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A New Thrust Bearing.

In our description of the Currier & Snyder drill press, in our issue of Sept. 22d, we stated that the spindle was provided with the Brownell anti-friction roller bearing. At that time we were not able to give particulars regarding the construction of this bearing, but are now enabled to do so.

Fig. 1 shows its application to the spindle of a drill press, and Figs. 2 and 3, as constructed for a thrust bearing for a propeller shaft. Referring to Fig. 1, it will be seen that it consists of three conical rollers working upon equi-distant radial studs, these studs being driven into a triangular shaped piece, which keeps them in their proper relative positions. Above and below the rollers are placed beveled track rings, one of which turns with the spindle, while the other is attached to the sleeve. Enclosing the whole is a case so arranged as to catch and retain the oil which passes down through the sleeve, so that the rollers and track rings run in oil. Where a number of conical rollers greater than three are used for a bearing of this kind, there is considerable difficulty in securing a uniform bearing on all the rollers, because it is not easy to make and maintain the rolls all of precisely the same size; or, if made and kept of the same size, a uniform bearing may not be secured, on account of the difficulty of keeping all the rolls at exactly the same distance from the center of motion.

The distinguishing feature of this bearing is the employment of three rolls only, and arranging them so that they will adjust themselves in use so as to distribute the pressure equally between the rollers. The triangular piece in which the roller studs are fixed is somewhat smaller outside than the case in which it turns, and the inner ends of the rollers do not quite reach the shaft; this leaves the rollers and triangle free to move one way or the other, which they will do until the pressure is equally distributed upon the rollers.

Supposing, for instance, that one of the rollers has been made, or has worn smaller than the other two, then if they are equi-distant from the center, of course the small one will take none of the bearing, and it will fall entirely upon the other two. But by giving the triangle room to adjust itself, it will be seen that as soon as the rollers begin to travel around between the rings, the two larger ones will be forced out further from the center by the pressure, and by their moving outwards the small one is drawn inwards until it comes to a bearing equal to that of each of the other two. A similar action would take place if one of the rollers were larger than the other two. A moment's consideration will show that this action could not take place if four rollers were used, or in fact with any even number of rollers, while with any uneven number, other than three, there would be no assurance of a bearing on more than three of them, and these three would rarely be equi-distant from each other. Of course the cone surfaces are made at such an angle, and the rolls arranged to run at such a distance from the center, that all the lines converge at the center of motion, and thus there is no other than rolling friction, except that of the rollers upon their studs, which is very slight. Various modifications in size and arrangement of the parts are made, as required by the conditions of case, and the bearing can be applied at any point along a shaft, or at a distance from either end; for instance, an upright water wheel shaft may be suspended from a bearing placed on the floor above, or a mill stone may be supported in like manner.

In Fig. 2 it is seen that there are two sets of rollers, which is, of course, necessary on propeller shafts. There is a square groove turned in the shaft, into which the collar seen in the center is clamped, it being made in two pieces for the purpose. This collar has a flange on each side, against which rest the

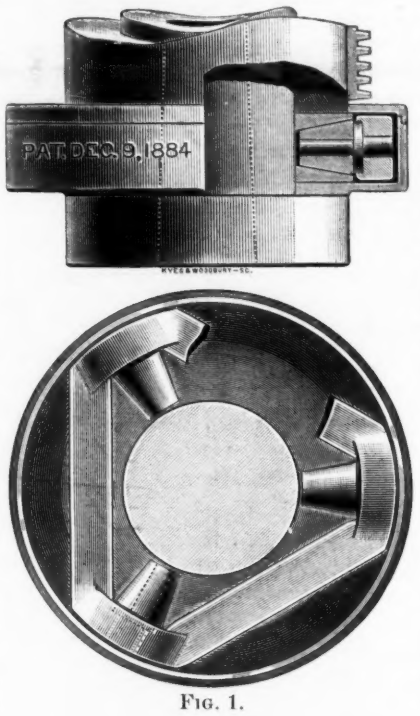


FIG. 1.

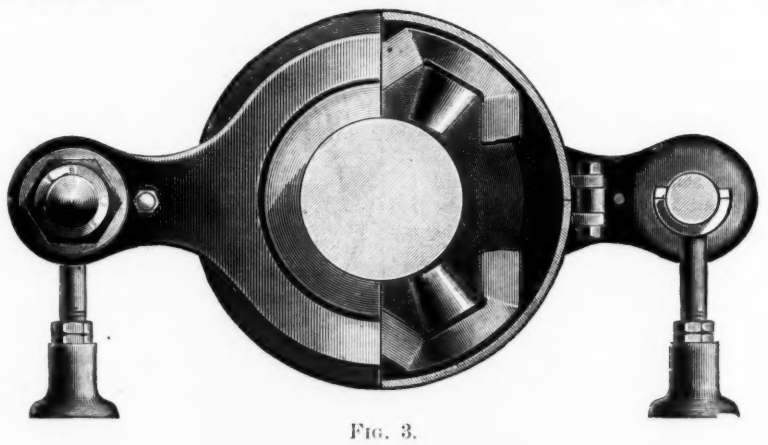
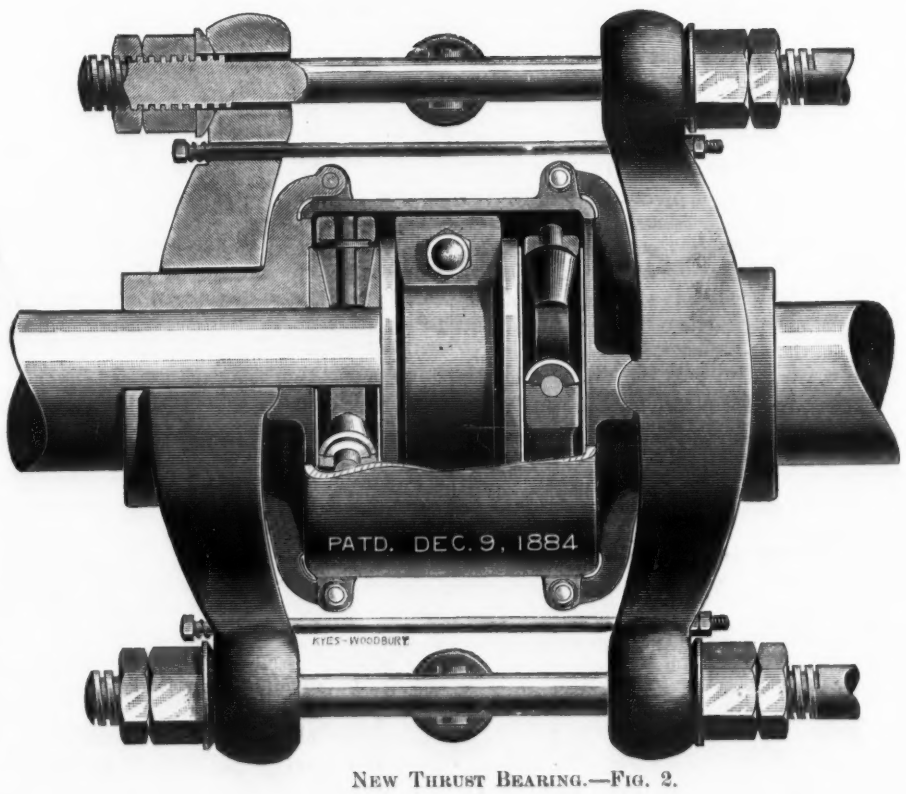


FIG. 3.



NEW THRUST BEARING.—FIG. 2.

two inner beveled track rings. The outside rings rest against cast flange pieces, one of which is shown partly in section, and which encircle the shaft, being held in position by the yokes through which the large bolts pass to the bed of the engine. The bearing between these flange pieces and the yokes is round, as shown, so that the parts cannot be cramped by unequal tightening of the nuts on the bolts. The nuts also rest on spherical washers, for the same object. Between the two flange pieces there is a case, made in two parts, and held in place by the four bolts passing through the lugs. This case is made sufficiently tight to hold oil, so that the parts are kept thoroughly well oiled. The small bolts passing from one yoke to the other, having spiral springs at one end, are intended to keep the parts up together, and prevent any rattling, which might occur without them, since the thrust is of course upon only one set of rollers at a time.

The adjustable studs under the side bolts (Fig. 3) are for the purpose of resisting the tendency to turn with the shaft. The inventor, Mr. G. L. Brownell, of Worcester, Mass., devised it for use upon machines of which he is the builder, and it has been in use on them upwards of four years, reducing the friction of thrust bearings in some cases 75 per cent., while the wear seems to be imperceptible. They are made of all sizes to order by the inventor as above, or he will grant rights under the patent.

Anatomy in the Machine Shop.

BY T. P. FARMER.

During a recent pleasure trip I visited many machine shops and factories, and, while witnessing some of the new and wonderful improvements that help to build the great monument which marks this age of progress, my attention was drawn to several incidents equally monumental in their absurdity; and the thought has occurred to me whether knowledge acquired through a mirthful spirit is not sometimes more penetrating than when viewed from a serious standpoint.

I was invited to examine a machine which, if ever completed, is destined to make a stir in the mechanical world, and which evinces a remarkable skill and ability in its construction, but for a blunder; and thereby hangs a tale. The inventor, a thoroughly practical man, a profound thinker, after months of study, with drawings constantly before him, has made a blunder so apparent that any machinist would observe it at a glance. This machine is large and peculiar in design, and when in motion is operated by a set of levers, which keep both hands of the attendant constantly employed. Now one of these levers is so situated that it is far beyond arms' reach, and the operator has to improvise means to get at it; as he cannot disengage both hands at the same time, it is impossible for him to walk around the machine, and any stationary cross-rod would interfere with the working of other parts; in fact, there seems no possible way out of the difficulty, except through an entire reconstruction. Being an old friend of the inventor, the machine was shown to me, with, perhaps, a vague hope of a suggestion, or, possibly, that I might condole with him in his misfortune; but upon seeing a large monkey-wrench used to facilitate that distant lever, and inquiring if it constituted a part of the invention, all expectations of suggestions or condolence vanished, and he forthwith explained, in a manner peculiar to himself, what he considered the true cause of his mistake. "If," said he, "I had given a little more attention to the study of anatomy, and a little less to mechanics, that thing would never have happened." Yes, if he had stopped to consider that the average man's arm is less than thirty inches in length, instead of over forty, he would have saved time, money, and annoyance.

In the regular line of machine shop tools of modern construction, the matter of convenience in their manipulation seems to have nearly reached perfection; but this is not always the case with machines designed for special purposes, and it is surprising to witness the awkward positions in which a man is sometimes obliged to place himself in his endeavors to operate them. Now, perhaps, if a little more attention could be given to the anatomy of the human form, much of this trouble might be avoided, for it is certainly more easy to build a machine that will conform to the man, than it is for the man to conform to some of the monstrosities called special machines, and with the possibility of becoming, in time, a monstrosity himself. If the designer would but consider the limits which nature intended the arm to reach, the back to bend, or the leg to be lifted, he would certainly be appreciated for his humane endeavors. If he would also bear in mind the average stature of men, and in the construction of his machines maintain average distances, paying special regard to height, he would confer a favor upon all.

In another shop I was greatly amused in witnessing the odd antics of a boy who was attending a punching press of unique pattern; it being operated by a treadle, the traverse or dip being so long, and the recoil so great, as to nearly drive the boy's knee into his chin at each performance. One who can tend that machine for any length of time—be he man or boy—deserves to be classed among the martyrs, for it must certainly be very injurious, to say the least; and here is another instance where a little study of anatomy would have been of value.

Beauty of design is another important feature to be considered when constructing special machines. It is the handsome furniture that helps to make the handsome parlor, and it is the attractive machinery that gives attractiveness to the shop; at the same time it should be remembered that superfluous projections, and embellishment in patterns can never compete with simple compactness and solidity.

Another amusing exhibit was a three-legged machine, having a triangular or three cornered bed-plate, said corners apparently having no other office to fill than to knock the knuckles or puncture the abdomen of those who come in contact with them. In answer to my inquiry, "Why not have the corners round, or the table itself round, for that matter?" "Symmetry," I was informed, "has to to be preserved." Symmetry, indeed! there was nothing symmetrical about it.

I have always been a strong advocate of the "line of beauty." I hate to see an angle where there can be a curve, and never fail to mention it; in fact, I almost believe that cutting tools and wits are the only two things essential to have sharp in the machine shop.

Now there is the same feeling experienced in noticing the general appearance of a machine that there is in noticing people, or animals. Our attention is quickly attracted by a fine form, or a handsome face, and we have a natural abhorrence of deformity; we ridicule or pity the horse made up of angles, and admire the one having well-rounded lines.

We frequently hear such expressions as "That's a handsome machine," or "That's an awkward looking thing." There is something in the general appearance or outline that is either winning or repulsive, as the case may be, and we speak of it almost before we think. We do not question the merits of the machine, but in the case of the awkward one we are apt to wonder if it could not be equally as good, and still be handsome; and nine times out of ten (when conditions will admit), by rounding off a few corners, and substituting curves for angles, it could be.

"Handsome is that handsome does," is the saying; and in one sense it may be true; but if we can have a machine that really is handsome, and at the same time embraces all the essential features, why not have it so?

In designing standards, bases, pillars, tables, or bed-plates for machines, sharp corners and acute angles should be avoided as much as possible; they seldom add to strength, never to beauty, are always in the way, and are the first places for the paint to wear off and rust to begin. Now, this particular machine of peaks and points I refer to, though perfect in the performance of its functions, was, in appearance, the maximum of ugliness and the minimum of taste. I will admit there are exceptions to all rules, and the mention of curves recalls to memory an incident which occurred in my early experience. I was employed to design a pedestal for a small machine, and requested to make it as symmetrical and graceful in appearance as I knew how. It was composed entirely of curves, oval flutes, and so on, there being neither angle nor flat surface upon it. When the drawing was shown to the party for whom it was made, he objected to the top ring in the horizontal fluting, insisting that it should be flat, to correspond and come flush with the bed of the machine. I at once began to expatiate on the beauty of curves as compared with straight lines; he took off his hat, and with a most polite bow, said: "Sir, I thank you for your compliment, it is the first I ever received." He was bow-legged.

In summing up the points along the line of observation, I am more than ever convinced that pleasant surroundings have much to do in producing good results. Attractiveness, cleanliness, and conveniency, are important factors conducive to health and happiness in all shops and factories. It is only from the healthful, contented man, that we have a right to expect good work. No one can be happy or retain his health who is obliged to operate the ill-designed, back-breaking machinery in some of the filthy places I call to mind; but thanks to progress, such machines and shops are a long way in the minority, and let us hope the time is not far distant when they will disappear entirely.

If I had the ruling of affairs I would have the workshop as attractive as the flowers of June—as enticing as the fruits at the "Harvest Feast;" I would have the tools as convenient as the "Magician's Wand," and the "Cup of Knowledge" more fascinating and exhilarating than the wine cup. Work should be a pastime—the workman's life like unto one long holiday.

A Class in the Theory and Practice of Steam Engineering.

An evening class in steam engineering will be started at the Young Men's Institute, New York, beginning Wednesday evening, Nov. 14th, and continuing Wednesday and Friday evenings, from 8 to 10 o'clock, until April 29th. It is proposed to give general instruction in the construction and care of engines and boilers, and such instruction as will enable engineers to pass the examination for license. Engineers and firemen will be admitted; also those employed in machine shops and boiler shops. The services of William H. Weightman, M. E., have been secured as instructor, a selection that will be recognized as a remarkably good one. We presume that any information desired by those wishing to join this class can be had at any of the rooms of the Young Men's Christian Association in the city.

Glass drip cups for line shaft hangers are made in England, and are said to possess some advantages over the iron ones.

Notes on the Expansion of Steam.

By Richard H. Buel.

TWELFTH PAPER.

Table D contains the general formulas for finding the degree of superheat which must be imparted to steam, in order that there may be no condensation within the cylinder of an engine, either on account of the work of expansion or by radiation, conduction, etc. The table also shows the results calculated from these formulas, for the various assumed cases of cut-off already considered. A few symbols are used in these formulas, which have been explained in former articles, viz.:

$\frac{1}{R}$ the real cut-off.

m, the mean pressure up to point of cut-off.

U, the mean pressure during expansion.

(I), the temperature of saturated steam at initial pressure, and the values of these quantities are taken from preceding tables. As already remarked, it is supposed that the expansion takes place in precisely the same manner for superheated as for saturated steam; and that at the end of each stroke, the cylinder and clearance space are filled with saturated steam at the same terminal pressure as obtains when saturated steam is used in unjacketed cylinders, with this important difference between the two cases, that when superheated steam is used the superheat prevents all condensation, so that the consumption of steam can be calculated directly from the piston displacement without any additional allowances. The final results are given in Table E, the effective horse-power and hourly steam consumption being taken from a preceding table, and the steam hourly per effective horse-power being the quotient arising from dividing the second of the foregoing quantities by the first.

Experimental data on the use of superheated steam in non-condensing engines are somewhat rare, but a few results suitable for comparison with the theoretical figures are presented in Table F; and indicate, as far as they go, that the theoretical results are not unduly favorable to the superheated steam. The experiments recorded in this table were made with a small engine whose condition and proportions were not such as to produce the highest economy, and the effective power of the engine was not measured. Possibly some of the readers of this article may be able to furnish additional experimental data.

The eighty-six formulas presented in the tables of this series of articles cover most of the conditions under which simple engines are operated, and being general in their character, are applicable to all assumed conditions, with a single exception, which will be noted hereafter. The results calculated from these formulas, with assumed conditions which do not vary materially from those found in good practice, will serve as a guide to the designer and steam user, showing figures which can safely be guaranteed or required in preparing the specifications of an engine.

The formulas can be used for condensing engines, under the conditions already assumed, or under other conditions chosen at pleasure; and the effect of attaching a condenser will next be considered, for the same cases which have already been discussed for non-condensing engines.

D.—Theoretical Results of Using Steam Expansively—Non-Condensing Engines—Unjacketed Cylinders—Steam Superheated Sufficiently to Prevent Condensation. (Results and General Formulas Specially Applicable to these Conditions.)

Item.	Symbol.	Formula.	Point of Cut-Off. Full Stroke	¾	½	⅜	¼	1-6	⅛	1-12	Number for Reference
Terminal pressure, pounds per square inch	(r)	$C \times \frac{1}{R}$	—	70.1	49.1	34.4	26.7	18.7	14.4	10.7	78
Volume of 1 lb. of steam, cubic feet. Atmospheric pressure (r)	(v)	From tables.	—	6.07	8.49	11.84	15.04	21 02	26.89	35.56	79
" " " " " " " " m	(o)	From tables.	—	4.48	4.45	4.41	4.39	4.38	4.37	4.36	80
Mechanical effect of 1 lb. of steam during expansion, foot lbs.	(P)	$[(v)-(o)] \times U \times 144$	—	18386	58361	66959	73342	91552	104328	118161	81
Units of heat condensed for work, per lb. of steam	(p)	$\frac{(P)}{772}$	—	23.8	75.6	86.7	95	119	135	153	82
Total heat, British thermal units per lb., above 32° Fah., of steam at pressure (r) — Saturated steam	(H)	From tables.	—	1174.3	1167.3	1160.5	1156	1150	1146	1142	83
Total heat, British thermal units per lb., above 32° Fah., of steam at pressure (r) — Steam superheated to prevent condensation due to work	(h)	$(H)+(p)$	—	1198.1	1242.9	1247.2	1251	1269	1281	1295	84
Temperature, Fah., of superheated steam, including 50° of superheat to prevent condensation due to radiation	N	$\left\{ \frac{(h)-1075}{.4805} + 32 + 50 + \frac{4}{20.403 \times \sqrt{r}} \right\}$	378°	397°	485°	490°	495°	528°	540°	587°	85
Degrees of superheat, Fahrenheit	(S)	$N-(I)$	50°	69°	157°	162°	167°	200°	212°	259°	86

E.—Theoretical Results of Using Steam Expansively—Non-Condensing Engines—Unjacketed Cylinders—Steam Superheated Sufficiently to Prevent Condensation. (Results Calculated by the General Formulas and Data of the Table Published in American Machinist, June 30, 1888.)

Item.	Symbol.	Point of Cut-Off. Full Stroke	¾	½	⅜	¼	1-6	⅛	1-12	Number for Reference.
Probable effective horse-power	(E)	150.6	151.5	148.8	147.5	150.6	148.8	149.8	150.1	39
Pounds of steam used hourly, calculated by piston displacement. Total	Q	5851	5539	3963	3494	3328	3268	3627	3925	47
Pounds of steam used hourly, calculated by piston displacement. Per effective horse-power	(W)	38.8	36.6	26.6	23.7	22.1	22	24.2	26.1	57

F.—Per Cent. of Gain by the Use of Superheated Steam in Non-Condensing Engines with Unjacketed Cylinders—Theoretical and Practical Results.

Theoretical Results. Point of Cut-Off.	Pounds of steam hourly per effective horse-power. Saturated steam.	Superheated steam.	Difference.	Per cent of difference.	Practical Results, from Experiments of U. S. Naval Board, Boston, 1877. Point of Cut-Off.	Pounds of steam hourly per indicated horse-power. Saturated steam.	Superheated steam.	Difference.	Per cent of difference.
Full stroke.	40.7	38.8	1.9	4.9					
¾	39.3	36.6	2.7	7.4					
½	30.3	26.6	3.7	13.9	.69	48.2	35.2	13	37
⅜	28.6	23 7	4.9	20.7	.46	42.2	31.7	10.5	33.1
¼	28	22.1	5.9	26.7					
1-6	30.2	22	8.2	37.3	.25	45.3	35.8	9.5	26.6
⅛	34.9	24.2	10.7	44.2					
1-12	42.2	26.1	16.1	61.7					

Railways in Chili.

The *Ferro Carril*, of Santiago, Chili, reports that two American engineers are now in that city, representing a powerful American syndicate, and that they have offered to contract for the construction of the railroads which the government intends to build. Their tenders amount in all to $35,000,000, being $5,000,000 more than the value which has been fixed by the government engineers. The tenders of the Batignolles Con-

struction Company, and of the French Commercial Company, for the construction of several of the proposed new lines of railway, were not accepted.

The Sturtevant Automatic Engine.

We present with this, illustrations showing two different views of an automatic engine built by B. F. Sturtevant, Boston, Mass.

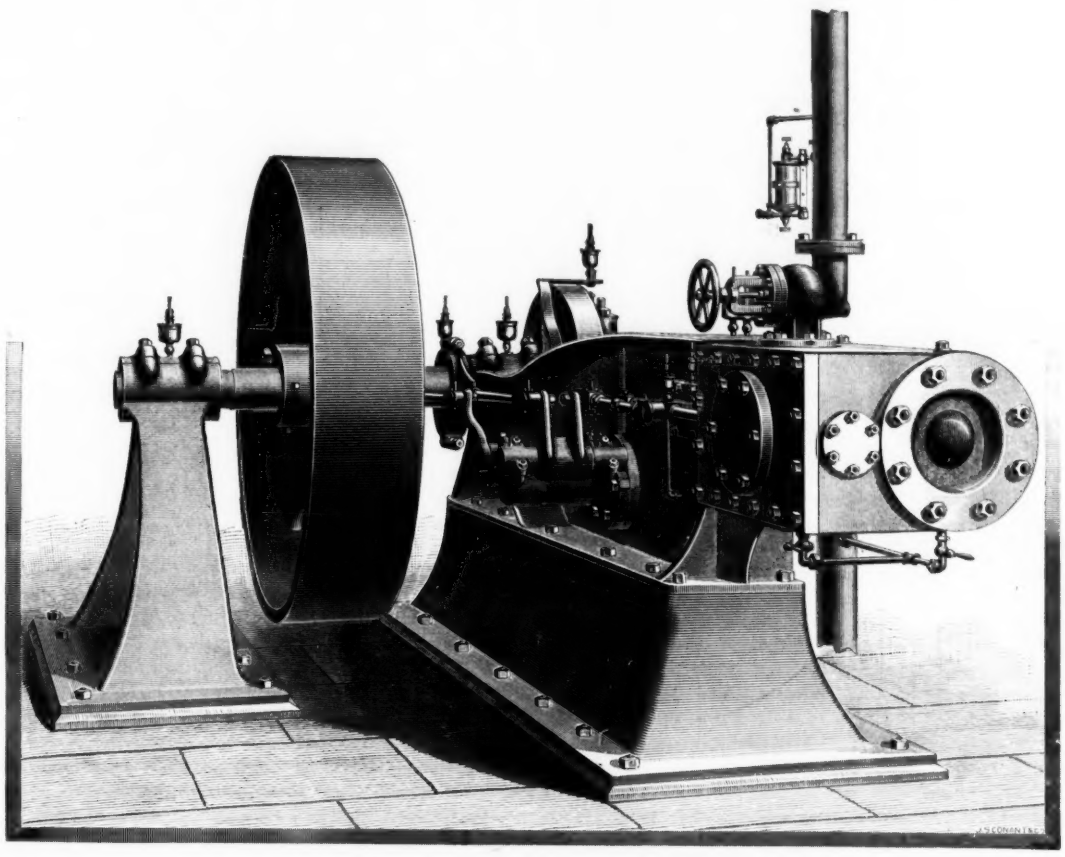
Mr. Sturtevant is well known as the manufacturer of the Sturtevant blower, and has for many years been making engines to meet the demands of customers who wished engines especially designed to meet the requirements of fan driving. The high speed at which blowers must be run, and the continuous service required of the engine, together with the uniformity of speed required, present conditions identical with those attendant upon dynamo driving, so that an engine especially designed for, and satisfactory for the one purpose, will of course be equally so for the other.

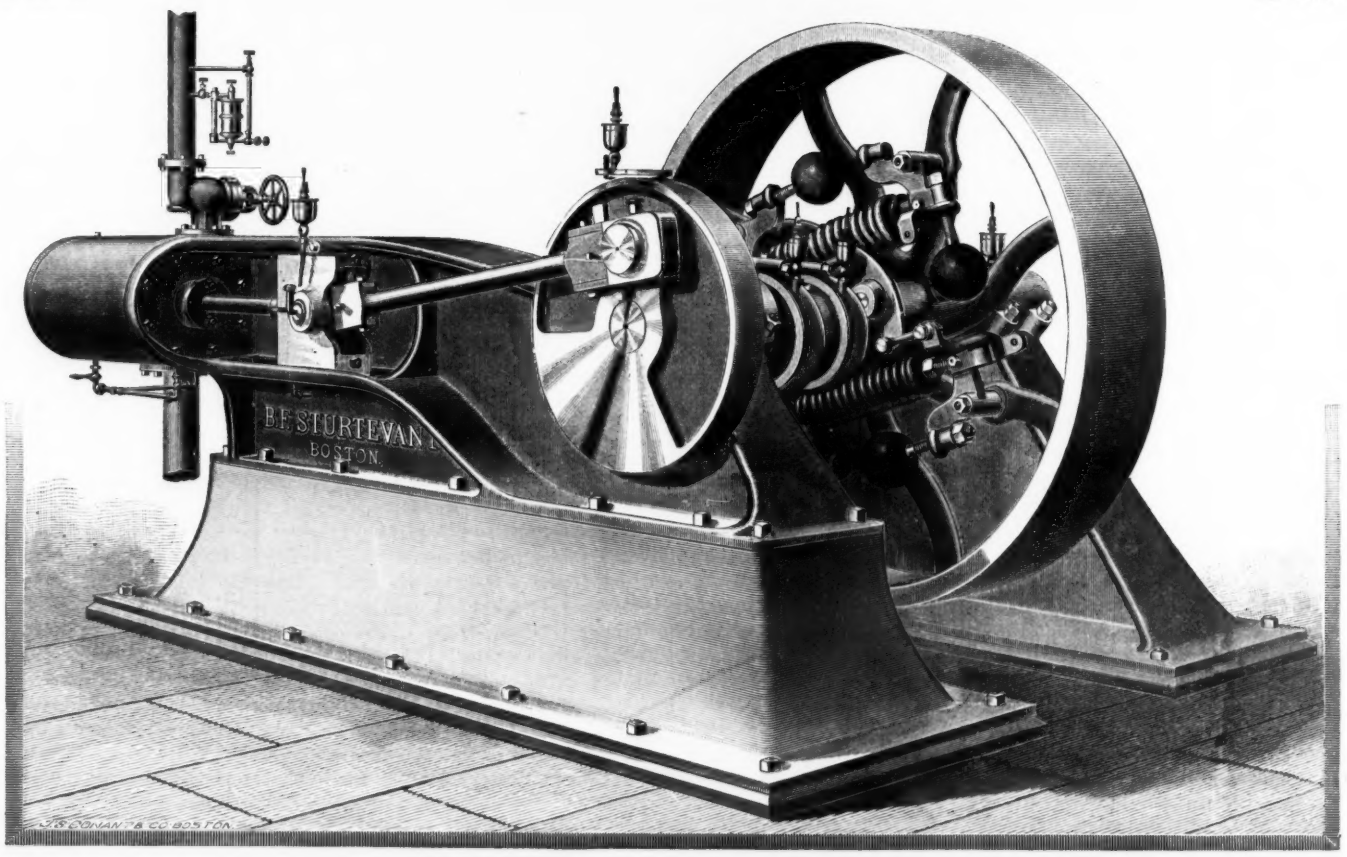
By reference to the illustrations it will be seen that this engine is so constructed as to reduce to the minimum the liability to wear out of alignment.

The engine proper, inclusive of the cylinder, is in one casting, and is so designed as to produce and maintain a natural, positive alignment of all the parts, not easily disturbed by transportation or service. Simplicity is aimed at by the reduction of moving parts to the fewest number possible.

There is in this engine a main and a cut-off valve, driven by independent eccentrics, the former being a flat balanced slide valve, having a fixed movement, designed to give uniform points of admission and cut-off and uniform compression; the cut-off by this valve being fixed at three-fourths of the stroke. The passages in the main valve do not extend entirely through it, as is usually the case when a riding cut-off valve is used, but resemble the exhaust cavities, except that they are only as wide as the steam port. Within this main valve is a cylindrical seat, in which is a piston cut-off valve, which receives its motion from an eccentric, the throw of which is controlled by a governor of the disk type. Thus the cut-off valve has such a motion relative to that of the main valve that it is withdrawn just before the beginning of the stroke, opening the passage through the main valve to the port. Since, at the moment of cut-off, the two valves are moving in opposite directions, cut-off is very quick, as is shown by the indicator cards taken from the engine.

The cut-off valve has comparatively little motion upon its seat, which, together with the fact that it is subject to no lateral pressure, makes it very durable in service. Then the relative motions are such that no leakage can possibly take place, except immediately after cut-off and during the earlier part of the expansion, when the steam chest and cylinder pressures are nearly equal; and the leakage can take place into the cylinder only —never into the exhaust. Of course the three-fourths cut-off of the main valve is not intended to come into action under ordinary circumstances, since the cut-off will take place, under ordinary conditions of economy, at less than half stroke.





The Sturtevant Automatic Engine.

By means of pressure plates upon the back of the main valve, it is balanced, and the power required to move it reduced to a minimum. The main valve stem is tubular, and provided with a stuffing box at its outer end, through which passes the cut-off valve stem. A small crosshead attached to the main stem relieves it of wear, and provides for the maintenance of accurate alignment.

The governor acts upon the same principle as others of its class; has four weights, which, together, act to compress two springs. The cut-off eccentric is pivoted to the hub of the governor, and is so connected with the system of weights and springs, that by their movement it is swung across the shaft to vary the cut-off. Dash pots are used to prevent too sudden action of the governor. The heavy weights, stiff springs, and balance valve combine to make the governor very sensitive, and the regulation under varying loads is shown by the Moscrop speed indicator to be very close.

The larger sizes are provided with a flywheel, independent of the governor, and, for the purpose of reducing the thickness of the main valve, two cut-off piston valves, placed side by side, are used instead of one.

The main journals and crank pins are of maximum size, to secure strength and minimum pressure per unit of area. The connecting rod has substantial stub ends, and easily adjusted boxes. The crosshead is of cast-iron, strongly ribbed, and provided with wedge adjustments for taking up wear. Improved oiling arrangements are provided, by which all the parts are positively oiled while running, the oil cups having adjustable sight feeds, and the running parts being provided with wipers for distributing the oil.

"Worthless Patents."

A correspondent writes us as follows:

In your issue for Oct. 6th, I notice an editorial entitled "Worthless Patents," in which it is stated, "Only a small percentage of all the patents issued from the United States patent office have any value." In ordinary business, it is thought a great increase of establishments in any particular line is pretty good evidence that there is profit in it. The large number of patents issued, and the constantly increasing number of applications for patents, is, on the same basis, evidence that it is a paying enterprise. As this is a subject in which I have long been interested, I shall be grateful if you will state the facts upon which you base so sweeping a condemnation of the system, which permits the issue of so large a percentage of worthless patents — patents which, by their worthlessness, amount to frauds upon the people.

We have faith to believe that our correspondent has not read the editorial in question with any great degree of care. There is nothing in it, so far as we can see, that can be tortured into a "sweeping condemnation of the system which permits the issue of so large a percentage of worthless patents." The American Machinist has always upheld the principle that the obtaining of a patent on an invention should be made easier, rather than harder. But it is a fact, for which we attempted an apology, that a large majority of the patents issued are worthless. If our correspondent will examine the patent records for the past twenty years, and will then take the pains to find out how many of the patents issued during that time have been worked to any useful purpose, we believe he will agree with us in the statement of a simple fact. But only a small percentage of ordinary business enterprises are successful. As we have before this said, there are more failures in such enterprises than there are of patents. Notwithstanding this, it would be better if fewer worthless patents were issued, if for nothing else, because this well-known fact is industriously used by those who are opposed to any patent law, or in favor of curtailing the rights of inventors. We commend the last paragraph of "Worthless Patents" to the consideration of our correspondent.

La Semaine des Constructeurs gives the following receipt to preserve cast-iron from rusting: Clean the casting and wash in dilute acid; when dry, rub the surface with a file or metallic brush; then give it several coats of raw petroleum, each being thoroughly dried before the next is applied. When the last coat is dry, rub well with a stiff "hair" brush, and a beautiful dull polish will be produced, that will resist a high degree of heat, and will not be attacked by rust. The polish may be indefinitely preserved and improved by the occasional application of a single coat of petroleum followed by the brushing.

Practical Drawing.

By J. G. A. Meyer.

SEVENTY-FIRST PAPER.

500. The underlying principles of the solutions of problems relating to the intersection of geometrical solids are applicable to the solutions of a great number of practical problems; therefore, a careful perusal of the problems relating to the intersection of surfaces here given, and those which are to follow, will prove to be of great value to artisans engaged in any of the various mechanical arts. Indeed, it may be said that the advantages derived from the study of these problems are twofold; first, it will aid the student in becoming proficient in reading and making practical drawings, such as are used in all first-class manufacturing establishments. True, the objects which come under our consideration in these problems are of a primary character, yet the principles embodied in the projection of these simple objects are precisely the same as the principles which guide the draftsman in making drawings of objects having very complicated forms. Take for instance the outline given in Fig. 378 (last paper). This the mechanic will at once recognize as a drawing of an elbow, yet this outline is nothing else but the projection or drawing of two cylindrical surfaces, and if we know the principles involved in making the drawing of a cylinder in its different positions, we will certainly know how to make a correct working drawing of an elbow. In a similar manner many cases in practice could be cited, in which the objects having apparently complicate forms, are nothing else but a combination of a number of simple geometrical solids; and if the principles pertaining to the projections of geometrical solids are understood, then many obstacles in learning practical drawing will be removed, as the apparent difficulties to be overcome in making a working drawing will prove to be delusions.

Secondly, a careful study of these problems will enable the artisan to lay out work. Consider, for instance, the method given in our last problem for finding the development shown in Fig. 380 of a cylindrical surface whose projections are given in Figs. 378, 379. The boiler maker or the tinsmith will follow the same method in laying out the sheets for elbows. True, in our last problem we have paid no attention to the lap required for riveting the pieces together, but this fact does not change the mode of procedure in laying out a sheet of this kind; in all such and similar practical problems, we must first find the development of the surfaces without taking the lap into consideration, and proceed precisely in the same manner in laying out the sheet, as we have done in finding the development of a simple cylindrical surface; after this has been obtained the lap is then added to it. But here another question will arise, namely: Will the manner of laying out a sheet for cylindrical shells of given thickness be changed from the manner of developing a cylindrical surface which has no thickness, as represented in the last problem? To this we briefly answer, "No." In order to give the reason for our answer we will take up the following problem.

Problem 75.

501. *Development of cylindrical plates.*

74. Let $a\ b\ a_3\ b_3$, Fig. 381, represent a vertical sectional view, and $a_3\ b_3\ d_3\ c_3$ a plan of a wrought-iron shell whose dimensions are given in the two views. It is required to find the size of plate for this shell before the plate is rolled to the cylindrical form.

In the illustrations the thickness of the plate has been purposely exaggerated, to enable us to show clearly the lines drawn through the center of thicknesses.

In Fig. 381 we see that the outside diameter of the shell is to be 18 inches and the inner diameter 17¾ inches; consequently the thickness of the plate will be ⅛ of an inch. Our first step will be to simplify our problem, so that in finding the size of the plate we will be justified in leaving its thickness out of our calculation. It will also simplify matters by assuming that the ends of the plate butt against each other, thereby throwing, for the present, the lap out of consideration.

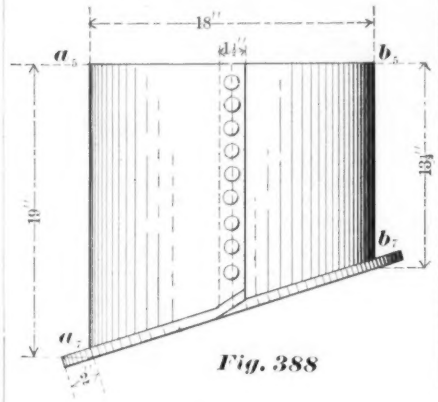


Fig. 388

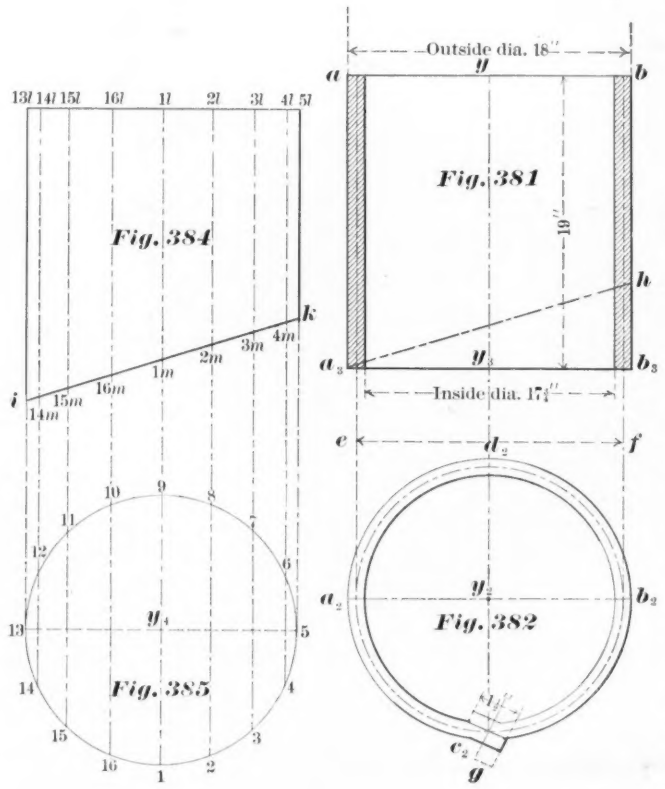


Fig. 381

Fig. 382

Fig. 384

Fig. 385

Subtracting the thickness of the plate from the outside diameter of the shell, we have $18 - \frac{1}{8} = 17\frac{7}{8}$. We now find the size of plate required for a shell $17\frac{7}{8}$ inches diameter, and proceed as if the plate had no thickness. In fact, we have now reduced our practical problem to a geometrical one, in which the diameter of the cylinder is given, and whose surface is to be developed. Therefore, we have only to find the circumference of a circle whose diameter is $17\frac{7}{8}$ inches. Consequently we have

$$17.875 \times 3.1416 = 15.156 + \text{inches, say}$$

$15\frac{5}{32}$ inches, which is the length of the plate. The breadth of the plate will of course be equal to 19 inches, that is, equal to the length of the shell. But so far we have not taken into account the required lap, which, according to Fig. 382, is to be 1½ inch. This lap we simply add to the length of the plate just found, hence we have

$15\frac{5}{32} + 1\frac{1}{2} = 16\frac{17}{32}$ inches.

Consequently the size of plate required for a shell shown in Figs. 381, 382 will be $16\frac{7}{32}$ by 19 inches.

502. In laying out the lines on the plate to which it is to be cut, we simply draw two lines $r\ t$, $s\ u$ (Fig. 383), parallel to each other and 19 inches apart. On the line $s\ u$ we lay off two points v and w; the distance between these two points must be equal to $15\frac{5}{32}$, that is the length of the plate without any lap required to form the shell; through the points v and w draw lines perpendicular to $s\ u$, cutting the line $r\ t$ in the points $1o$ and $1p$, and thus obtain the rectangle $1o\ 1p\ v\ w$, which, as we have already seen, is the size of the plate required, provided its ends simply butted against each other. To the length of this rectangle we add to each end one-half the lap; thus, draw the line $x\ r$ parallel to $1o\ v$; the distance between these two lines must be equal to ¾ inch (one-half the lap); and at the other end draw the line $w\ t$ parallel to $1p\ w$; the distance between these two lines must also be equal to ¾ inch. The center of the rivet holes will lie in the lines $1o\ v$ and $1p\ w$; and the sheet must be cut to the lines $r\ s$, $t\ u$, $r\ t$ and $s\ u$.

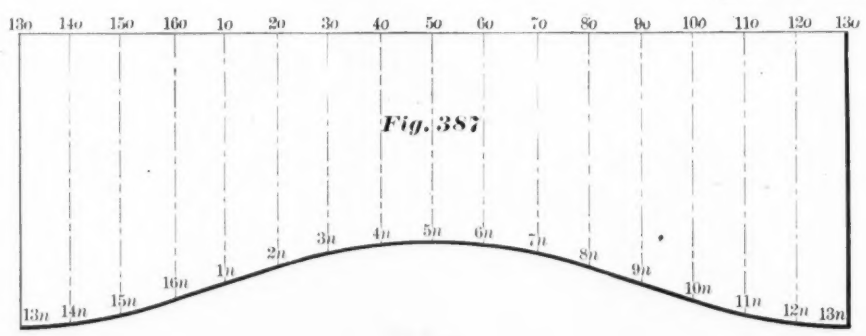


Fig. 387

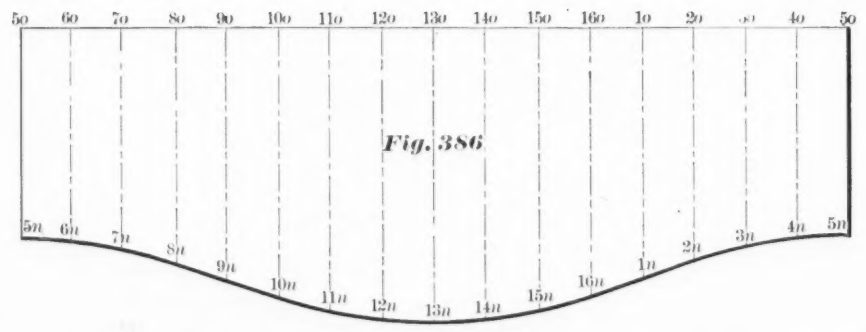


Fig. 386

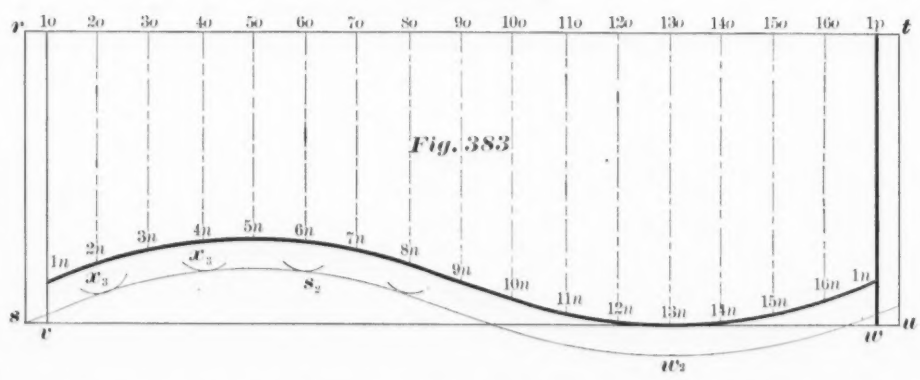


Fig. 383

503. Now let us consider a moment whether or not we are justified in subtracting the thickness of the plate from the given outside diameter of the shell, and making the length of the plate suitable for a cylinder of this reduced diameter, as we have done. In rolling a plate to the required cylindrical form, one of its surfaces is stretched or elongated and the other surface is compressed. It is generally assumed that one surface is elongated as much as the other surface is compressed, consequently there must be a plane in the thickness of the plate which undergoes no alteration in length, and this plane must, according to our assumption, lie in the center of the thickness. When the plate is rolled to the required form, then this plane, which undergoes no alteration of length, will be represented by the dotted circumference of the circle described through the center of the thickness, as shown in Fig. 382. The diameter of this circle will be equal to the line $e\ f$, and this line is equal to the outer diameter, minus the thickness of the plate. Now, since the inner surface of the plate will be compressed, and at the same time its outer surface elongated in rolling the plate, it must be obvious that the length of the plate before it is rolled must be equal to the circumference of a circle whose diameter is equal to the outer diameter of the shell, minus the thickness of the sheet. The assumption that, in rolling, one side of the plate will be stretched as much as the other side will be compressed may be considered to be true for all general boiler work. But when we have to deal with plates of comparatively extreme thickness, the foregoing assumption may not hold quite true, and consequently, when great accuracy in workmanship is required, plates laid out by the method given may not be quite satisfactory. This will in no wise affect the principles of the method for laying out the plate, but it will affect the amount which, in the first place, must be deducted from the outer diameter of the shell, and the exact amount which should be deducted from the outer diameter of the shell can only be determined by practical experience.

Now suppose that one end of the shell represented in Figs. 381, 382 is to be cut off as indicated by the line $a_3\ h$, Fig. 381, and let it be required to lay out a sheet suitable for that portion of the shell marked $a\ a_3\ b\ h$. Here then we have a problem often met with in practice. Indeed, cylindrical shells cut to this form we find on sloping tanks for locomotives; hence, we may state our problem in the following manner:

Problem 75*a*.

504. *Practical application of Problem* 74.

It is required to lay out a plate for a cylindrical manhole shell to be placed on the sloping part of a locomotive tank. The dimensions of this shell are given in Fig. 388. Thickness of sheet, ¼ of an inch; vertical lap as shown in Fig. 382.

Our first step will be to make on a blackboard a full size drawing of the shell, similar in outline to that shown in Fig. 384, from which we can lay out the plate. In this drawing the rivet joint and flange should not be shown, but simply a plain outline, as represented in Fig. 384. The diameter $13l\ 5l$ will be, for reasons given in Art. 503, equal to $18 - \frac{1}{8} = 17\frac{7}{8}$ inches; the line $i\ 13l$ will be 19 inches long; and the line $k\ 5l$ will be 13½ inches long. From any point y_4 as a center (on the center line $1l - 1$) and with a radius of $8\frac{15}{16}$ inches, describe a circle. Divide the circumference of this circle into any even number of equal parts, say sixteen. For the

sake of convenience in laying out the plate, commence the division of this circumference from the center of lap, that is from point 1, and mark the points of division, 2, 3, 4, etc. Through these points of division draw vertical lines, cutting the line *i k* (Fig. 384) in the points 2*m*, 3*m*, 4*m*, etc.; also cutting the line 13*l* 5*l* in the points 2*l*, 3*l*, 4*l*, etc. It should be remembered that the lines 2*l* 2*m*, 3*l* 3*m*, etc., represent elements, or we may say, represent lines drawn on the cylindrical surface. It should also be remembered, that since the points 4 and 6 (Fig. 383) lie in one vertical line, the line 4*l* 4*m* represents two elements in the cylindrical surface; and for similar reasons, all the vertical lines in Fig. 384, excepting the lines 5*l k*, 13*l i*, represent two elements.

We are now ready to lay out the plate. On it (Fig. 383), draw the line *r t*; and on this line lay off two points 1*o*, 1*p*; the distance between these points must be equal to the circumference of the circle shown in Fig. 385, namely $17.875 \times 3.1416 = 15\frac{5}{16}$ inches. Divide this distance into sixteen equal parts; that is to say, into the same number of parts as spaced off in the circumference (Fig. 385). Mark the points of division (Fig. 383), 2*o*, 3*o*, 4*o*, etc., and through these points draw lines perpendicular to *r t*. Now make the length of the line 1*o* 1*n* equal to the length of the line 1*l* 1*m* (Fig. 384), the line 2*o* 2*n* equal to 2*l* 2*m*, and so on until the length of the line 5*o* 5*n* has been laid off. The length of the line 6*o* 6*n* must be equal to the length of the line 4*l* 4*m*; 7*o* 7*n* equal to 3*l* 3*m*, and so on in rotation until the line 13*o* 13*l* has been laid off. The line 14*o* 14*n* must be equal to 14*l* 14*m*; 15 *o* 15*n* equal to 15*l* 15*m*, and so on until the line 1*p* 1*n* has been reached, which is again made equal to 1*l* 1*m*. Join the points 1*n*, 2*n*, 3*n*, etc., by a curve, then this curve and the straight lines 1*o* 1*p*, 1*o* 1*n*, and 1*p* 1*n* would be the boundary lines of the plate, if there had been no lap; but since Fig. 388 calls for lap we must now add it to the outline just found in Fig. 383. Now, since the vertical lap is to be $1\frac{1}{2}$ inches, draw the line *r s* parallel to 1*o* 1*n*; the distance between these two lines must be equal to $\frac{3}{4}$ inch. Also draw the line *t u* parallel to 1*p* 1*n*; the distance between these lines must again be equal to $\frac{3}{4}$ inch. We must now add the flange, which is to be 2 inches. Hence from the points 1*n*, 2*n*, 3*n*, etc., as centers, and with a radius of 2 inches, describe short arcs, as indicated at x_3, x_3, then draw the curve $s s_2 x_2 x$ tangent to these short arcs, cutting the lines *r s*, *t u* in the points as shown. Mark off the centers of the rivet holes on the lines 1*o* 1*n*, 1*p* 1*n*; and cut the plate to the lines *r s*, *t u*, *r t* and the curve $s s_2 x_2 x$.

If the center of the vertical rivet joint had been at the point 5 (Fig. 385), then the development of the plate (without lap) would have appeared as shown in Fig. 386. And lastly, if the center of the joint had been at the point 13, then the development of the plate would have appeared as shown in Fig. 387. The numbers prefixed to letters on the lines in Figs. 383, 386, 387, indicate that these lines represent the lines supposed to be drawn on the cylindrical surface, similarly numbered in Fig. 385; this will enable the student to follow the construction easily.

Comparing the construction in the present problem with that in Problem 75, it will be seen that the constructions are identical, yet in the former we have developed a plate of given thickness, and in the latter we have developed a geometrical surface, that is, a surface having no thickness.

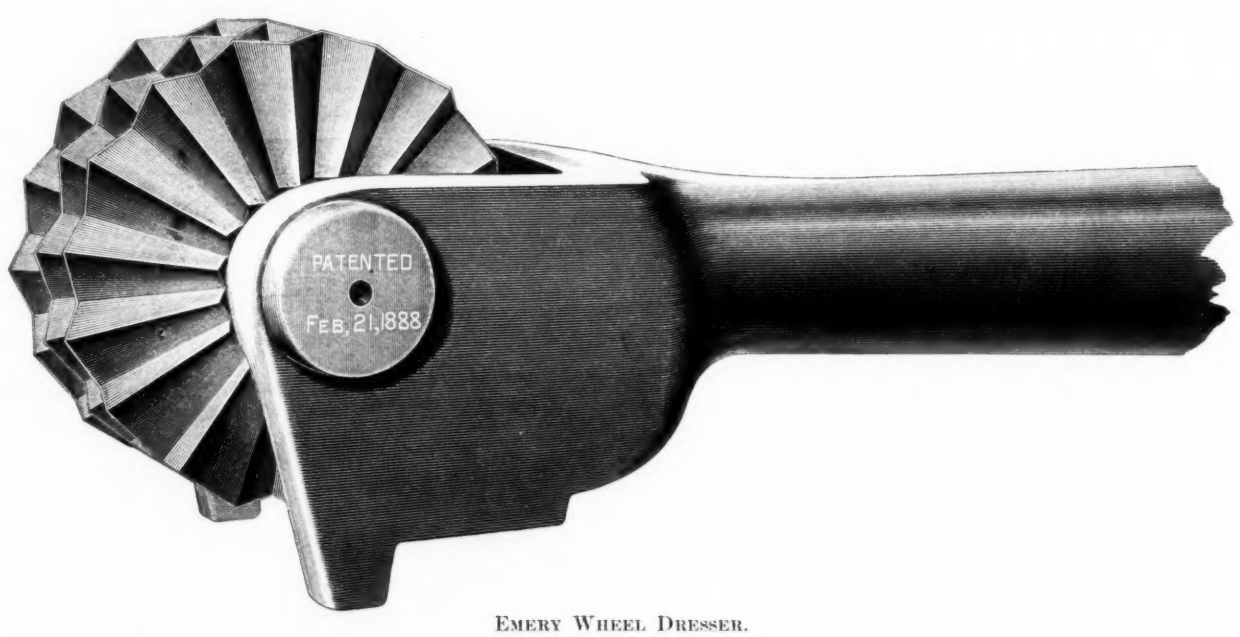
Directions.—In space marked Prob. 75, draw the development of a manhole shell, whose dimensions are given in Fig. 388. Use $\frac{3}{4}$ in. scale.

A New Emery Wheel Dresser.

Experienced emery wheel users fully appreciate the value of a tool which can be kept always at hand, and can be applied to the wheel at any moment, either to make it true or to remove the effects of a glaze. It is with the object of supplying such a tool that the Norton Emery Wheel Co., Worcester, Mass., have placed upon the market the tool which we illustrate herewith.

The cutters are corrugated, and made in such a shape that they can be used until worn down nearly to the hub. They are cast of a composition specially adapted to the purpose, which renders them very tough and durable, and run on a steel pin which is easily removed and readjusted when new cutters are required. As the cut shows, the entire tool is so designed as to be neat and serviceable, and we have no doubt will meet with a favorable reception by emery wheel users.

A Duluth man proposes to cheapen the transportation of grain to Europe, by enclosing it in cigar-shaped cylinders of steel, which are to be filled with wheat at Duluth, sealed up, and towed through the lakes to Buffalo, and from there, via the Erie canal and Hudson river, to New York, where an ocean-going steamer will take a large raft of them in tow, and pull them across the big ferry. It is thought to be practicable, and that it will be much cheaper than by railroads, canal boats, and steamships, with the necessary transfer and elevator charges.



EMERY WHEEL DRESSER.

Steam Pump Practice.

BY HIRAM R. JONES.

If a suction pipe is obstructed; too small or too long, the pump will be "starved," so to speak, and if the velocity of the plunger is greater than the inflowing water, there will be a partial vacuum formed between them, and on its return stroke the plunger will strike the advancing water with great violence, producing a severe shock and strain on the valves and joints of the pump and pipes.

A partial remedy for this evil is to put a large air chamber on the suction pipe near the pump. This will make an elastic cushion of air for the incoming water to come in contact with, and so not strike the returning plunger with so hard a blow. But while a suction chamber is always an advantage, it will not stop the pounding if the average of the volume of water is not enough to follow in close contact with the plunger. In this case the proper remedy is to put in a larger suction pipe.

Many a good pump is blamed for not doing its work smoothly, when the only trouble is a restricted supply of water. In some situations, in order to bring the pump under the immediate charge of the engineer, it is necessary to use a very long suction pipe. In such cases it should always be one or two sizes larger than the pump connection calls for, and the water should flow to the pump from a head, or have a very moderate lift.

Should there be a leak in the pipe, so as to allow air to enter, the plunger will act something like the case just mentioned, but instead of the plunger striking with a solid blow, it will impinge against the air cushion formed. The first part of the return stroke will be very quick, but will gradually slow down to its normal speed as the imprisoned air is compressed, but without severe shock, as in the former case.

If the suction pipe is short and vertical, and has a leak in it, the pump will discharge about the same quantity of air at each stroke, but if it runs a long distance horizontally, and the leak is near the far end, the action of the pump will be spasmodic, sometimes getting solid water, and then great pockets of air will flow into it, causing it to dance back and forth for several strokes before it will get water again. If the pump is working against a heavy pressure, and there is much clearance, air will sometimes come in in such large quantities that the stroke of the plunger will not be sufficient to compress it enough to lift the discharge valves, and the return stroke will not expand it enough to produce vacuum enough to lift receiving valves. In this case, the action of the pump will be very much like compressing and releasing a spiral spring between the palms of the hands. When a pump works this way, engineers say "she has lost her water." Should this happen, close the valve in discharge pipe, and open the pet cock until the air is out, and water appears.

As what is going on *inside* of pumps and pipes is hid from the sense of sight, our knowledge of their diseases depends very largely on the action of the piston, and the sounds produced—the causes of which we must reason out. We can see them only with our mind's eye. If pumps and pipes were transparent, we could see the air moving along always in the highest place it can find, like the bubble in a spirit level. Fill a glass bottle with water nearly full, cork it, tip it about in various positions, and the relative positions of air and water are readily seen.

I would suggest, right here, that makers of philosophical school apparatus make pumps and engines of glass, in order to show what is going on inside. Make long suction pipes, short ones, small ones, large ones; provide leaks in them in various places, to be controlled at will. Make vertical curves with elevations and depressions, to show how air traps impede the flow of water. In this way the flow of water, and pump action, can be shown, and much more clearly than it can be described without this aid.

All pumps with high lifts or long suctions should have a foot valve *just above the water level*, and have it so arranged that it can be got at for examination or repairs without breaking the pipe connections.

A primer is very convenient. It is simply a small pipe with a valve in it, connecting the discharge pipe with suction. By this means the pump and suction can always be charged and ready for instant use, should it stand for some time unused. It should be closed when pump is working.

It will also serve to detect any leaks which might occur, and would not show up were there no way to put pressure on suction pipe.

A *very small leak* in a suction is an advantage, as it keeps the air chambers charged, which would otherwise become filled with water as the air became absorbed by it. In pumps that are perfectly tight—a rare occurrence—a pet cock should be provided below the receiving valves, to admit air occasionally, if the pump begins to pound.

Hot water or boiler feed pumps have diseases peculiar to themselves. When water is heated to about 100 degrees Fahrenheit it will begin to boil in a vacuum, and produce steam with an increasing pressure as the temperature rises, until the boiling point in the open air is reached, when the pressure of the steam will just equal that of the atmosphere. Now the sucking action—so called—of a pump is not such as to *pull* water in to itself as you would pull a boat towards you with a rope, but simply to produce a partial vacuum by moving away from the water and allowing it to follow after, forced in by whatever pressure there may be on it, whether atmospheric or otherwise.

Water heated nearly to the boiling point in the open air has just pressure enough on it to keep it from producing steam. To show what would be the result of trying to pump this water, we will introduce a case in practice. Suppose that it is attempted to pump it from a heater or cistern, the water level of which is two feet below the pump. Now to force this water into the pump will require an additional pressure of nearly one pound on the surface of the water, or what would be its equivalent, the removing of the same amount of pressure from the surface of the water standing in the suction pipe. Suppose that we start the pump and remove nearly one pound of pressure, as indicated. The result will be that the water immediately boils and produces steam, and we would pump steam instead of water. If the speed of the pump is increased slightly we pump both steam and water, and with not very smooth action either, for this steam, unlike the air, would be condensed by the returning stroke of the plunger, and what little water may have entered with the steam will be met with a blow like a steam hammer. The remedy is to raise the level of the water, or lower the pump so that the water will have some head or fall to the pump. The action, as above described, will sometimes occur when the water level is as it should be, but suction pipe too long, too small, or contracted by valve elbows, etc.

In pumping very hot water, an open stand pipe connected to the suction, and running up a foot or two above level of water in the heater, will be of service in allowing any steam that may be present to escape to the open air, but this is not to be generally recommended. Hot water should have sufficient fall to flow to the pump solid. Some plan should be provided, however, to admit air to the pump occasionally, to supply that absorbed by the water, otherwise the pump and feed pipe to boilers will pound severely.

It may be accomplished by having a stop valve in both suction and delivery pipes, and a pet cock in each of these pipes, between the stop valves and the pump. Should the pump pound for lack of air in its chamber, close the stop valves and open the pet cocks until the chamber is recharged with air, then close the pet cocks and open the stop valves and the pump will work smoothly. Try it if there is a hammering in the feed pipe.

Oil for Fuel.

The *St. Louis Daily Globe-Democrat* contains a long account of the success of the St. Louis Shovel Company in the use of crude oil, burned by the use of the devices furnished by the Aerated Fuel Company, of Springfield, Mass. According to the *Globe-Democrat*, oil costing $2.10 gives the same results as coal costing $6.60, besides reducing the cost of labor 25 per cent., and greatly reducing waste. The oil gives a clean fire, the intensity of which is governed at will. The device for burning this fuel was illustrated and described in the American Machinist of April 14, 1888.

LETTERS FROM PRACTICAL MEN.

A Controversy on Piston Packing.

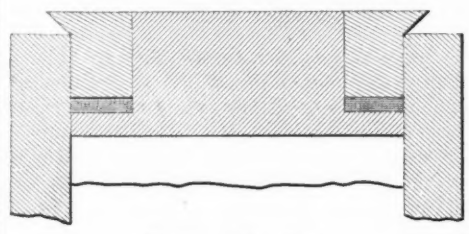
Editor American Machinist:

Not long ago two traveling men called, and both introducing a "new and improved piston packing." One called in the forenoon and one in the afternoon, and between them my duties for the day were somewhat neglected; still, I think the time was profitably employed, even if there was no money in it for either of us. I received them kindly, but informed each that if they did not have something more durable, simple, and cheaper than the packing I was using, that it was not necessary for them to make an exhibit. The packing I am using is the popular kind, viz., rings turned larger than the cylinder—cut—sprung in and doweled with the cuts, near the bottom of cylinder. When the natural spring of the ring was worn out a steel wire spring, put on the inside of the ring, renewed its elasticity and consequent usefulness, without adding any objectionable features.

Well, inventor No. 1 said that his packing had so much common sense in it that he insisted on showing it. I made up my mind while he was getting his traveling bag emptied (for that contained his packing in various forms on a small scale), that I should make all the objections I could think of, for the purpose of not only drawing out all the points of his packing, but the inventor also, for I recognized him as a man of some ability as a talker. His packing was made as follows: rough out the rings, make a lap cut, then spring them together and re-turn them to the size of cylinder. It did look a trifle hard to find any objection to his packing at first, but when he said he did not dowel the rings, but left them free to revolve in the piston at will, I asked him how he stopped the leaks when his rings worked around with the cut, away from the bottom of the cylinder. He replied that with a lap cut the steam could not get through, no matter what the position of the ring was. I told him I held a different opinion about that, and showed him that when his rings got worn so there would be a space at the ends of his lap, that the steam could go in at one end and down under the joint and out at the other end. This was very obvious after shown to him, though often overlooked. I finally forced him to admit that, so far as leakage was concerned, that a lap cut was no better than a diagonal or any other kind of cut.

We next took up the subject of roundness of rings, after they are sprung together. To illustrate his views on this point he picked up an old ring which one of the boys used as a parallel to keep work off the chuck or face plate of his lathe, and sprung it together, and said, "Measure this across this way, and then across that way, and see the difference." I did so, and found it to be 6¾" in the direction of pressure, and 7" the other way, and the two ends of the diagonal cut looked just a little like the worm of a rail fence. He made some very caustic remarks about mechanics putting such rings into cylinders to distort them—to leak and produce undue friction, etc., etc., while they could just as well, by paying him a small royalty, make a perfect packing from the start, and not depend on wearing a fit which was sometimes ruinous to the cylinder as well as packing.

To have been candid, then, I should have had to admit that he not only had the best of the argument, but perhaps the best packing, also, and should have tried his packing, had he not insisted that it must be either in a new cylinder or one newly bored that the trial should be made. I should have let the subject drop there, had I not felt called on to say something in support of a packing so extensively used, and that had given such excellent satisfaction, so I picked up the ring he had just laid down; I put a clamp on it, so the pressure would come on the cut and a point opposite, and began to screw up, till the pressure, with the aid of a little side pressure, closed the cut. I now measured, and found the ring to be slightly bulged out on the sides opposite the line of pressure, as might be reasonably expected. Our inventor applied his pressure to the ring at right angles



Packing No. 2.

to the direction in which I compressed it, and made it look bad indeed, but it would not be compressed that way when sprung into a cylinder, but nearer the way I compressed it; and since thinking the subject over I am led to believe that the pressure of the ring on the wall of the cylinder will be nearly equal all the way around, especially if the ring is turned eccentric. The wearing of old rings that I have seen seem to support this reasoning, as they were worn very uniform all the way around.

I do not know of any experiments that have been made to develop any facts in this particular line, so will drop No. 1, and take up packing No. 2. This packing has some very remarkable features, "not only being an excellent packing, but having the faculty of truing up old cylinders that needed reboring," and in proof of this several testimonials were offered. I submit a sketch of this packing which I make from memory, which shows a section of the packing rings and a broken section of T ring and followers. The rings, instead of being turned square, as usual, are provided with a cutting edge, as shown in the sketch. The primary object of the projection was to "let the steam wedge in under the ring and top of follower, and keep the packing set out against the wall of the cylinder." I considered this a very questionable way of setting out packing, but this subject was dropped to take up the more important one of boring out cylinders that had been distorted by the use of common packing, or any other cause whatever. I asked the inventor or agent of this packing—I don't remember which he said he was—the following series of questions:

How do you tell when your packing has just got the cylinder "trued up"; in other words, how do you keep it from boring the cylinder out larger than necessary? He replied that he did not know, but that *it did stop at just the right* time, as this testimonial says.

What are your rings made of? Cast iron. Does it make any difference if the rings are soft and the cylinder hard? No. If the rings are hard and the cylinder soft? No. If the pressure is high or low? No. If it is a high speed automatic, or throttling old style? No. Does it require any previous training, or a more skillful engineer, to manipulate this boring-tool packing than the old kind? No. He refused to answer any more questions, but offered unquestioned testimonials as proof of all he claimed for his packing. These parties must have had extraordinary good luck. I have seen cylinders rifled out, and the packing fluted to match, but never thought it possible to successfully bore cylinders that way. The old-fashioned, three-ring packing, when provided with diminutive jack-screws, and run by an engineer with small brain and large muscle, was the kind and circumstances under which the feat would be most likely to be accomplished. I recommended this packing in case he ever found a cylinder that was too much for his own packing. I do not wish to be understood as condemning the three-ring packing, for, where well made, and intelligently run, there is no packing that I know of that is superior to it.

C. O. Sine.

Turning Balls.

Editor American Machinist:

The article in your issue of Sept. 29, by Fred J. Miller, on "Fixtures and Tools for Turning Balls" induces me to add a few devices which I have used and found to give excellent satisfaction for what they were intended, producing practically round balls and rapid work.

Fig. 1 represents a tool for turning a spherical surface on brass something like that shown, which we use. It will give the best results only on brass or other soft metals, and will make excellent work. *C* is a cast-steel sleeve bored out to nearly the size of the ball to be turned, being bored and tapped something smaller at the rear, to receive the shank *A*, to the other end of which a wooden handle is attached. This sleeve is cut out at *a*, as shown for a considerable depth back from the face, to escape the shaft of the ball. The internal surface of the sleeve, after hardening, is ground out true to size upon a grinding machine. The face *B* as well. The ball is first roughed off with an ordinary lathe tool or a hand tool, after which a tool *D* in the post of lathe is brought into position with the shank

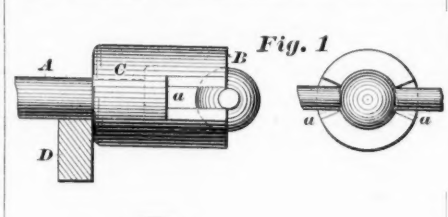


Fig. 1

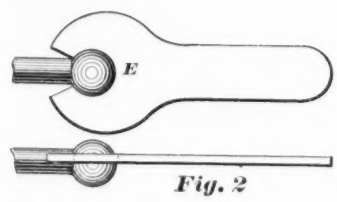


Fig. 2

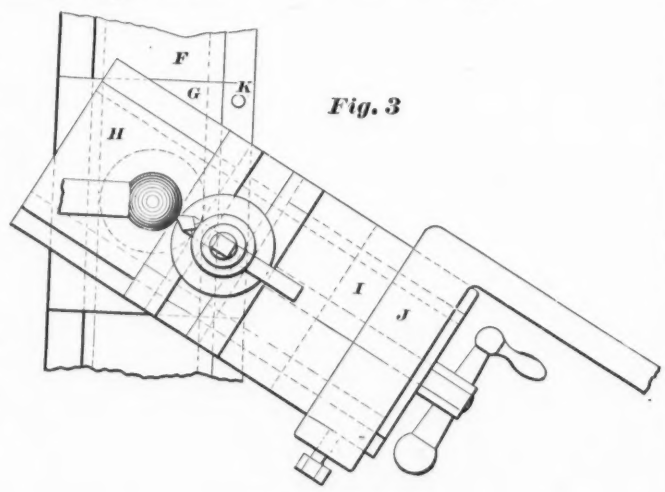


Fig. 3

Turning Balls.

A resting on it. Holding the tool by the handle with one hand, and with the other operate the cross-feed screw and press the tool over the ball. This it will be seen will make a perfect sphere, exactly to size, without taking any measurements. As the tool becomes dull the face *B* is ground back, and produces a new keen cutting edge. This operation can be repeated until the slot *a* becomes too shallow to allow the tool to pass over the ball, when it will have to be replaced by a new one. It, however, has given long service before this became necessary.

Fig. 2 represents another tool for finishing small balls of brass or soft metals. In this case the shank of the ball is held in the chuck. The ball is first roughed off and then finished with the tool *E*, which consists of a plate of steel bored out for the ball and cut through to escape the shaft. After hardening, the hole is ground out to exact size, and true, and both slides ground off to produce a keen cutting edge around the hole. After roughing off the ball this tool is held in the hand and simply pressed down over it, without returning, which also produces a true ball and exact to size. It must be remembered that this tool is only intended for small balls, as it could not be held to turn large ones.

Fig. 3 represents another device for turning balls; there is, however, nothing special about it, as it is found in readiness in most machine shops, and in most cases will take the place of the device shown by Mr. Miller, in Fig. 4 of his drawing, with the extra expense avoided. It will be readily seen that it consists of the regular compound rest found on many lathes (some, however, are not adapted to do this work, but quite a number are). *F* is a portion of the lathe carriage; *G* the cross sliding base of compound rest; *H* is the swiveled part of the rest and *I* the sliding part, to which is attached the tool post; *J* is a handle clipped over the rest *I*, and held by set crew *L*. This handle is made to pass off to one side, to escape the feed screw crank. After getting the center of rest correctly under the center of the work, a dowel pin hole *K* is drilled and a pin inserted. This will always therefore be in readiness for accurate centering. Thus set, a true ball can be turned of any diameter which the compound rest will admit. We use this arrangement for turning ball-ended links, having a ball on each end. After turning one end, to turn the other the finished end of the link is held in a chuck, coming against a stop at its end. The lathe carriage is then set to make the link of correct length. A stop is fastened to the shears of the lathe, against which the carriage is now brought. This makes all links of the proper length. These devices have proven quite satisfactory, and any one using them will find them so.

A. B. Landis.

"How to Reduce Drawing-Room Expenses."

Editor American Machinist:

Apropos of the article in the American Machinist of October 6, regarding the saving of expense in the drawing-room, there is good reason for Mr. Rogers to expect a "kick," not only on the part of masters of drawing, but also on the part of draftsmen. The experience that teaches that the fewer the figures on a drawing, the less the time lost in studying it, is the exception, and the precept deduced therefrom may be misleading. Of course, useless figures tend to confusion; but brevity carried to too great an extent sacrifices clearness and creates ambiguity. It is better to err on the safe side, and less time would be lost because of too many figures than because of too few. Hence the rule above indicated is an unsafe one to follow.

As to "Chordal's Code," what would be thought of a pattern maker who did not allow for shrinkage and draft? Is it necessary to instruct a workman in the very simplest details of his calling, since "he knows his own trade better than any one else"?

"Holes, with no size given, are to be cored to size." If the hole has no size, how can it be cored to size? This is not hypercritical, but some one must know the size and nature of the hole. If it should be cored, the draftsman should mark it so on the drawing, and give its dimension.

"Do not measure when figures are given"; by which is implied that the drawings must be measured when there are no figures. This is a practice to be condemned. If it be necessary to have the dimensions of a part, have it marked on drawing, making the draftsman, who ought to know better what the dimension is, responsible.

"Don't forget the fillets and rounds on all round work." If fillets and rounds are shown, they won't be forgotten.

"Mark all patterns with a symbol and number." If a piece is to be of brass, mark the pattern brass; cast-iron for cast-iron;

wrought-iron for wrought-iron, and so on, which describes right off the material, without symbols or anything else.

As to the blacksmiths, mark the finish as well as rough. The finish, as a rule, is more important than the rough: why tax the blacksmith to remember what don't take but a few minutes to make plain on drawings.

The instructions to machinists are tame, and don't fit with the assertion that he must be credited with better knowledge of the business than any one else. If all these instructions constitute a simple or perfect system, it must indeed be a very poor mechanic who does not do every one of the instructions by intuition.

Sheet No. 1 is the most complete. It is true there are needless repetitions, and that the figures could be put on to better advantage. It is noticed that on none of the sheets are over-all dimensions given—very useful figures for all hands. There is nothing complicated about the drawing; it is plain; all it lacks are some marks where finish is to be allowed. In sheets Nos. 2 and 3, while they may answer the purpose for which they are intended, where is there a pattern maker who would prefer to make a pattern from them in preference to sheet No. 1? It takes more of a draftsman's time to study out how much he can leave off a drawing for some one else to do than it does to settle right down and make the drawing properly. Certainly a draftsman should dictate all arcs, curves, and finish lines; he knows better where the centers of arcs and curves are, and should mark them. There is no sense in leaving that for the pattern maker to work out. A draftsman that does this kind of work gets to be a very good machine; in fact, he develops into a regular "mechanical draftsman." But the boss don't despise him; his traits are good ones, and he can be depended on; while the fellow who is always arguing that the other fellow in the shop knows better than he does what is wanted, is generally in hot water the best part of the time.

If it were not necessary for the graduate to make the teeth in the gear wheel, he should not have been permitted to do so. But the "kid" did not do the same work in an hour; he made something that would answer. If the "kid" has followed up Meyer's articles he has got a good foundation to start on, and deserves credit for his study. At the same time, the ability of the graduate must not be judged from the fact that he took fifteen hours to do a job which, in his inexperience, he considered was necessary to show the gear properly. There was no reason for snubbing the young man with a taper attachment. Where is the man that learned the requirements of drawing in a term of school? Actual contact with work and practices as they are carried on in the shops is where the experience must be gotten, by the technical graduate as well as the apprentice; and it is wrong to fire into either when we know they are not experienced enough to be competent to judge for themselves. It is essential that the students should be taught how to section and show shade lines, in order that he may know how to do it. It is just as reasonable to show the nature of a material by a certain style of sectioning, as to use a symbol to designate it.

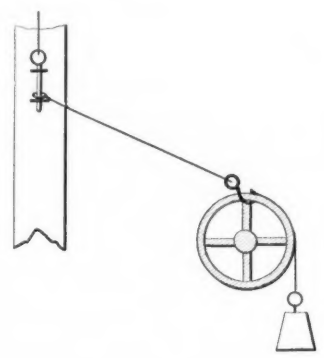
Chordal's rules, kinks, and instructions would not answer for the student. What he aims at is to have men apply what they have learned in its simplest forms, not because they have learned some other way of doing work, but to simplify the means to an end; and it is certainly false economy that decreases the cost of one branch of an industry at the expense of another. W. S. Huson.

An Automatic Throttle Valve.

Editor American Machinist:

Dropping in to see a friend is my favorite way to find how other men run engines, and to gather new ideas. Singular though it may seem, the brightest ideas and clever overruling of things difficult and inconvenient, into things pleasant, are not always found in the big plants; sometimes quite the reverse. For instance, at a plant where they ought to know more, I see they use red lead on every gasket, from boiler to cylinder.

I dropped into a laundry the other day, and saw a very clever thing. It is about this way: The proprietor wanted the engineer to stay close to the engine, as the girls were afraid of being caught in the machinery. The engineer didn't want things to run that way, and this is how he dodged that work. He took the hand wheel off the throttle valve and had a groove cut in the rim, replaced it on the stem and hitched a small cord and weight in such a manner that when the valve was open the weight was up. In a convenient post he drove a pair of small staples. Directly above these, near the ceiling, was a spool for cords. The rig was put together in this manner: the throttle being opened, the cable was wound up in the groove—down the staples was dropped an eye-pin through a ring (see cut), hitched to a cord which run to



hand wheel, and had a small hook to engage the wheel. The leading cord ran through screw hook over to the ironing machine, and had switches to various places, where needed. It only needed a pull of one inch to pull the staple pin, and thus allow the weight to act.

Now Ed was a gentleman of leisure; there was one drawback, they had to hunt him to start up again. This led to the borrowing of a gong from the fire department, and getting one cast from it. After being turned up and rigged out with trigger, etc., he easily connected it with the eye-bolt, so that the stoppage of that engine was known half a square.

Most men would have rested here, but not this one. The next move was toward the clock, an old style striking one. More screw eyes and cord was called into use, and the result was that as the striking hammer of the clock started to announce 12 o'clock, bang went the 15″ gong, and shut went the throttle.

That was the state of affairs two weeks ago, and I can't say what further improvements have been reached by this time. Will go down to see him to-morrow, and expect to find the engineer rustling around, trying to get some new way to avoid the Adamic curse.

Springfield, Ohio. Thos. T. Parker.

Design, Construction, Repairs and Management of Marine Steam Engines and Boilers.

By W. H. Hoffman.

FIFTEENTH PAPER.

A plan view of the steam cylinders and steam chests will show comparatively short passages to the inner walls of the cylinders. The diameter of the piston valves for each cylinder will be so proportioned that the travel of the valves will be the same on the three cylinders. The ports in the high and intermediate pressure cylinders will have an area equal to $\frac{1}{15}$th the area of their respective pistons, but the area of the ports in the low pressure cylinder will be $\frac{1}{10}$th the area of its piston. Having arranged our engines for a high piston speed, we must provide large port openings, being especially careful to relieve the low pressure piston from all the back pressure so frequently found, and which is generally caused by cramped passages.

We go to the expense of making a large and costly cylinder, and we should therefore endeavor to make this cylinder do its full share of the work.

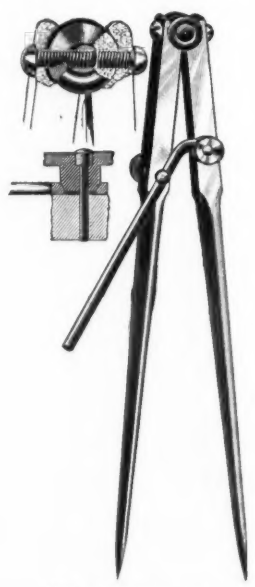
The valve stems, connections and pins, will be alike on the three sets of the valve motions, and will be interchangeable throughout. On the lower end of each valve stem there will be a bronze journal box, keyed fast to the stem, and fitted with the cap and adjusting half box and bolts, while in this box or bearing will oscillate the main valve stem pin, that transmits the valve motion to the stem. To the ends of this pin will be keyed, and safely pinned, two links that will be long enough to reach quite below the brackets that support the valve stem plunger guide, and the lower ends of these links will carry a pin of the same dimensions as the one attached to the top ends.

In order to clear the sides of the valve stem plunger guide, the links will be 7″ apart, and the valve stem pin journal will be 7″ long, and as it is 3″ in diameter it will be seen that we furnish an extraordinary bearing surface for this work; but these surfaces are a sure preventive against noisy pin joints.

The quadrants of the valve motions will be different in design from those usually applied to the Hackworth-Marshall gears, and herein lies the adoption of just one detail of the Kirk valve gear; but this detail is used for some other purposes than reversing and "hooking up." I speak of the bell-crank quadrant used by Mr. Kirk; that in his design is situated directly under the lower end of the main valve stem, and is used as the reversing quadrant. We shall use a similar quadrant, and shall locate it just above our eccentric lever; but this quadrant will be inverted, the ends of the curved portion pointing downward, or in the opposite direction from those of Mr. Kirk's gear. There will be a trunnion on each quadrant arm, like that of the above named gear, and this trunnion will rest in an adjustable box that will be moved by an adjusting screw to the extent of $\frac{1}{4}$th of the length of the eccentric lever. This motion will of course be athwart ships, and will be for the adjustment of the valve motion.

The point of suspension on the eccentric lever will also be adjustable, as this lever will have a rectangular slot, with a movable block therein, this block (which is the fulcrum bearing) being held in any position desired by a simple square threaded adjusting screw.

It will be seen by following the description, that we have at the main points of motion in our valve gear, the means to adjust to absolute accuracy the travel of the valves for each end of the cylinder, barring perhaps an almost imperceptible variation, due to the swinging of the lower end of the suspension link, that hangs from the quadrant block. By this arrangement, also, the travel of the valves under or over their normal movement, can be changed at will for adjustment, without shifting the quadrant.



New Dividers.

Our valve motion proper consists of only five pieces for each cylinder, while in some of the late radial gears there are ten pieces, and very few of them have less than eight. One block in the main eccentric lever does not slide while the valve gear is in motion, but is moved by the hand screw for adjustment only.

To the quadrant block, that is moved for reversing and "hooking up" on the high pressure cylinder, are attached two links 18″ long from center to center, the other end of these links being attached to a sleeve crosshead.

Through this sleeve crosshead we pass the end of a steel rod, $2\frac{3}{8}$″ in diameter, with collars on each side of the crosshead, so arranged that the steel rod can turn freely in the crosshead.

On the opposite end of this steel rod is a square thread, $2\frac{3}{4}$″ in diameter on the outside, cut 2 threads per inch, and this threaded portion of the rod runs in the hub of the piston of a small rotary engine, the piston acting (when the rod is locked) as a nut.

Should it be necessary to move the valve gear by hand, the piston is locked by a simple device, and the screw is turned by the fly-wheel of the rotary engine.

The fly-wheel has a sleeved hub running in boxes just outside of the cylinder, and is locked and unlocked from the piston of the rotary engine by a sliding movement of 1″. The reversing of the rotary engine is done by a sliding valve over reversing ports. The reversing quadrant blocks for the intermediate and low pressure cylinders are moved through the medium of one rock shaft, and two levers and links, the rock shaft being operated by the steel reversing rod, that is worked by the rotary engine.

By using a rotary steam engine for reversing, we provide a method that can be operated at any required speed, and one that will start at any point in the revolution, the instant the throttle valve leading to it is open. It is simple, compact, and easy to repair, and is capable of exerting its full power almost on the instant, which is not the case with the *reciprocating* reversing engines that are fitted with a crank shaft.

Direct steam reverse gears, unless fitted with an oil cylinder for retarding the motion, are not easy to control, and are more or less complicated in their valve arrangements.

New Dividers.

The accompanying illustration shows a new form of dividers brought out by A. T. Koopman, Chicago, Ill.

The joint consists of a thimble of hardened steel, through which passes a pin, also of hardened steel. In one side of the thimble is a slot, through which one of the screws which secure the legs passes, and is tapped into the steel pin. The opposite screw is tapped into the thimble, and secures it firmly to that leg. It is thus seen that, by adjusting the first named screw, all lost motion can be taken up, and the joint made as close as may be desired.

The usual flat arc, spring and thumb-screw, are replaced by a new device, the construction of which will be understood from the engraving. The milled head, which is on the right hand leg, is an eccentric, having the lower edge beveled and fitted to an eye formed on the end of the wire, as shown in the sectional view at the left; so that by tightening up the screw which passes through it, all lost motion can be taken up. The other end of the wire passes through the small eye bolt, which is tightened by the milled head at the left. When the points are set approximately to the right distance the wire is clamped, and the fine adjustment to the exact distance made, by turning the eccentric milled head.

A pair of these dividers, seen by the writer at the store of Montgomery & Co., this city, show good workmanship, are very substantial and well made, entirely of steel, with points tempered ready for use.

It is said that the Krupp works of Essen are to go into the manufacture of aluminum. The material used is cryolite, from Greenland, and chemically pure aluminum is promised at about $1.50 per pound.

The shipment of Cyprus lumber to Mexico and South America is quite large, and rapidly increasing. It is said to be better for many purposes than native wood.

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A New Patent Court.

It is to be hoped that the proposed bill for the establishment of a court of patent appeals will be passed, and the court put at work as soon as possible. Under the law an inventor's right to his property in a patent is limited to a few years at best, and under the present regime it frequently happens that a good portion of that time is consumed in litigation and in the delays caused by the present courts being over-crowded. It sometimes requires from three to four years for an inventor to ascertain what his rights are under a given patent, and it will be conceded that this is an injustice. Not only is it an injustice to the inventor, but important operations, which it is to the interest of the community to have pushed forward as rapidly as possible, are often delayed, and their benefits in some cases permanently abridged.

The proposed court is to consist of one chief justice and two associate justices, to be appointed by the President, by and with the advice and consent of the Senate, and who shall receive a salary of $6,000 per annum, and hold office during good behavior. Judge Culbertson, chairman of the House Judiciary Committee, which has reported in favor of the bill, gives the following as among the advantages which may reasonably be expected to result from the establishment of the court.

1. It would enable the public and patentees to determine the value and validity of patents without serious and vexatious delays, and thus promote the interests of all concerned.

2. It will relieve the Supreme Court of much of the burden imposed upon it by this class of litigation.

3. The practice in the Patent Office would become thoroughly fixed and understood, and, as a consequence, the issue of worthless patents, in which unscrupulous persons deal, to the injury of the public, would be greatly diminished, if not entirely suppressed.

4. It would tend to simplifying the patent laws by constriction, and settling questions of doubt which are often used by litigants for the purpose of injustice and oppression.

There would seem to be little room for doubt but that the establishment of a special court for the decision of such cases, to relieve the Supreme Court, would prove very beneficial to inventors and manufacturers, especially as the judges composing it would devote their entire time to patent causes, and presumably therefore become more thoroughly familiar with the mechanical and scientific knowledge required for such cases, in addition to legal learning.

A Cheap Accident.

The recently published report of the Toledo, Peoria and Western Railroad for the last fiscal year, shows that the amount paid by the road to the families of persons killed in the Chatsworth disaster was $180,000; which was $19,000 less than the net earnings of the road for the year, and is about $660 for each claim. In view of all the circumstances, we feel bound to say that the company are to be congratulated upon their favorable settlement of the matter, and as to the victims and their families, why—well, the next time they wish to travel, they can, those that survive, either walk or take some other road. But is there any assurance that, if they do take some other road, that road will be any less likely to lead them into a death trap? The consequence of this occurrence, so far as the road is concerned, simply amounts to the passing of one annual dividend. And the public seems to have accepted in full of all claims $180,000. But is this all? Are the same conditions which led to the Chatsworth disaster, and other conditions no less dangerous, to be allowed to be ever present upon the railroads of the country, and to be a standing menace and threat of instant death to all who must travel upon them? Are not the conditions which secure almost absolute immunity from such accidents well known? And is there anything in connection with Chatsworth, with Ashtabula, or any other of the many horrible bridge accidents, which will act as an impelling force toward the securing of the conditions of safety? What does the passing of one annual dividend amount to? A number of Wall street gamblers recently made a pile of money out of such an incident recently. Why should not the public demand that every foot of railroad track should be constantly under the eye of patrolmen? It would seem as though the wages of men had been reduced to the point which would enable the expense of a complete and thorough system of patrolling to be borne, and that, with skilled government inspection of bridges at frequent intervals, would render such horrors well nigh impossible.

We venture to say that when the Interstate Commerce law was enacted, its advocates did not dream that such a question would ever come before the commission, as was decided by it a few days since.

It seems that the railroad lines competing with the Burlington and Northern concluded that the rates of that road were ruinously low, and sent in a modest request to the commission to raise them, upon the ground that the law requires all railroad charges to be just and reasonable. The commission, however, seems to take the ground that the railroads are themselves to be the judges as to how low the rates may be made, while it is the commission's business to look after the interests of the people, by seeing to it that rates are not unreasonably high. It holds that Congress, in requiring rates to be just and reasonable, meant to legislate in the interest of the people—not the corporations. There is a suspicion in the minds of many, that Congress does not always legislate in that way, but the conviction is strengthening, that the passage of the law in question is a case in which it did. At any rate, the commission seems to hold the opinion that the object was, not to protect the railroads from each other's competition, but to protect the public against extortionate rates.

The ultimate disposition of all the pins made is a problem that has long bothered the curious. But just now comes the question, What becomes of all the railroad cars made? There is a scarcity of freight cars for nearly every purpose, and this scarcity is causing considerable trouble in various branches of business. Cars are wanted to move grain, to move coal, to move coke, and for various other purposes. A year or two since, it was generally believed that there were too many car shops in the country. But it is evident that they cannot supply the demand for cars, or that the roads are not willing to order to meet their wants.

The Sugar Trust has ordered the Bay State Sugar Refinery, at Boston, closed. This little diversion of the trust throws about three hundred men out of employment, and is all in the interest of increasing the price of sugar, which means that less shall be used, and hence, that there will be less work in refineries. The operation of the sugar trust so far has been to curtail the use of sugar, thereby depriving many of its use, and throwing men out of work.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(449) E. A. S., Philadelphia, asks some questions regarding the making of reamers, selection of cutters for the teeth, etc., which he will find answered in the answer to Question No. 460. Roughing reamers should be about the same pitch as others, though they are sometimes made coarser in order to get stronger teeth.

(450) A. B., Baltimore, Md., writes: I would like to know how to calculate the power of hydraulic elevators, and other water-works. Will you kindly tell me which book will give me the required information? *A.*—Study the principles of Hydrostatics found in any good Treatise on Natural Philosophy. After these have been mastered take up any good treatise on Hydraulic Power and Hydraulic Machinery.

(451) Stuck, Decatur, Ill., writes: I wish you would give me an explanation how to set the Marsh reverse gear used on so many threshing engines. It bothers a great many engineers throughout the West. I asked the old man, but he looked wise, and advised me not to give myself away, and took pains not to tell me anything about it. *A.*—We do not know to which reversing gear you refer. Send us a sketch of the same, however rough, but make it so as to enable us to understand it, and we will give you the required explanation.

(452) H. J. F., Baltimore, Md., asks: 1. How much do railroad companies have to pay for railroad ties? *A.*—The price of railroad cross-ties varies, and will depend on the location of the road, and also on the ratio of the supply and demand. In estimating the cost of laying a railroad track, the cost of each cross-tie is generally taken at 60 cents. 2. What is the difference of the price of cast-iron and malleable iron? *A.*—The difference of price will depend on the size and form of castings, and also on the localities of the foundries. Write for price to the nearest foundries to your place of business. Your third question is very indefinite. Inform us for what purpose the castings are to be used, and we will answer your question.

(453) E. H. G., St. John, N. B., writes: I enclose copy of analysis of water made for a mining association here. It is very destructive on boiler plates, as witnessed by condition of flue 10 inches diameter, 5-16 thick, only used eighteen months, of which I enclose you a sample. The company have tried nearly all compounds to prevent the destruction of plates, but with no success. From the analysis and sample of plate, could you suggest anything to counteract this villainous fluid? Water is taken from an open pond, is partly spring and partly surface water. *A.*—We believe the best thing, in fact the only thing that can be done, is to take the feed water to the boilers from some other source. It may be possible to accomplish this by digging a well, artesian well or otherwise; or you may have to take the water from some other locality through a system of pipes, so as to obtain a purer water for the supply of the boilers. The sooner that this is done the better it will be for the company, as the water which you now use is dangerous.

(454) G. I., Philadelphia, writes: Please give a rule by which I could get the horse-power which can be transmitted by shafting of different sizes at different speeds. For example, how much power will be transmitted by a shaft ⅞ inch in diameter, running at 1,800 revolutions per minute? *A.*—For turned shafting under ordinary conditions,

$$H = \frac{D^3 \times R}{90}$$

where H = horse-power, D = diameter of shaft, and R = number of revolutions per minute. This means simply that the cube of the diameter of the shaft, multiplied by the number of turns per minute, and that product divided by 90, gives the horse-power. By this rule the capacity of the shaft you mention would be computed in following manner: The cube of ⅞ or .875 = .67; this multiplied by 1,800 = 1,206, which, divided by 90 = 13.4 horse-power, and the shaft will transmit at that speed from 13 to 14 horse-power. The formula would of course be modified for steel shafting, cold-rolled shafting or for short lengths simply transmitting power.

(455) J. J. W., Wahoo, Neb., writes: 1. Please give me a description of motors or engines in which compressed air is used. *A.*—We do not know of any motors using compressed air which are at present in successful operation. Various experiments have been tried and motors built, but these did not do the work required of them, and were finally abandoned. We have illustrated and described a motor of this kind in our issue of Oct. 18, 1879. A number of these were built, and at one time it seemed that these motors would meet all expectations. But after they were put into regular service they did not give satisfaction, and were one by one reluctantly laid aside. To reproduce a description would take too much room, and furthermore, since it did not work as satisfactorily as expected, another description of it would be of no value or interest to our readers. 2. If two cubic feet of air are compressed into a space of one cubic foot, would the pressure of the air be doubled? *A.*—Yes, provided the temperature of the air remains constant.

(456) C. F., New York, asks: 1. Will I need an engineer's license for acting as engineer on a small steamboat 14 feet long, 2 feet beam, 17 inches high, and must the applicant be 21 years of age? *A.*—We believe that you will need a license; and if you have the required experience, your age will not prevent you from obtaining a license. Our answer is based on the following paragraph, copied from the general Rules and Regulations prescribed by the Board of Supervising Inspectors of Steam Vessels: "No original license shall be issued to any person to act as engineer, except for special license on small pleasure steamers, who cannot read and write, or who has not served at least three years in the engineer's department of a steam vessel, or as a regular machinist in a machine works, provided that any person who has served for a period of three years as a locomotive or a stationary engineer may be licensed to act as engineer on steam vessels after having had not less than one year's experience in the engineer's department of

a steam vessel." 2. Where shall I apply for a license? *A.*—To the supervising inspector, George H. Starbuck, Post Office Building, New York.

(457) F. H. K., Cleveland, O., writes: 1. Which is the best ink for stamps used for stamping tracings in the drawing room, so that the lettering made with the stamps will have the same appearance as if they had been made with India ink? It is also desirable that the ink shall not injure the rubber faced types. *A.*—There is a special ink made for the purpose, generally called "drawing room stamping ink." You may obtain this ink from any first-class dealer in drawing materials. 2. How can the ink be made to flow from a round hand pen which is used for lettering drawings? *A.*—There should not be any trouble in making the ink flow from such pens. If there is trouble, it is either caused by the pen being out of order or the ink dirty or not mixed to the required fluidity. In such cases you may have to throw one or the other, or both, away. 3. Have the railway master mechanics any standard size for their drawings? *A.*—No 4. Are there any standard sizes of drawings? *A.*—No; each machine shop generally establishes a standard of its own which will be the most suitable for its special kind of work. 5. Has there been at any time locomotives fitted up with the Corliss valve gear? *A.*—Yes; Mr. Corliss tried the experiment, but it was not a success. 6. Can the last four years of the AMERICAN MACHINIST be obtained at the regular price, and how much for binding? *A.*—They can be obtained at the regular price. Bound volumes for each year, $3.50.

(458) J. B., Allegheny City, Pa., writes: I am learning my trade and have had occasion to make some check-valve nuts; they were turned off and there were to be slots 1 9-16 in. apart around the circumference. Now, for instance, if there was to be 3 slots, or 2, 6, 8, 10, 12 or any other number, will you please give a simple method of figuring that out? *A.*—We are not sure that we understand just what you mean, but if it is desired to divide the circumference of a circle, so that the divisions will be 1 9-16 in. apart, it cannot be done unless the circle is of such a diameter as to make it divide into some whole number. For such work as you speak of, if it is required that the notches shall be just 1 9-16 in. apart, and the number of notches is given, you can find the diameter to turn the nuts by multiplying 1 9-16 in. by the number of notches, and dividing this product by 3.1416. But if the nut is turned up and the notches are to be cut as nearly as may be to 1 9-16 in. apart, then multiply the diameter by 3.1416, and divide this product by 1 9-16, which will give you a whole number or a fraction for a result. If the latter, you can cut the nearest whole number to it. For instance, suppose the nut to be 3 in. diameter, $3 \times 3.1416 = 9.4248$, which is the circumference of the nut. 9.4248 divided by the decimal equivalent of 1 9-16 — 1.562 = 6.03, and consequently 6 notches evenly spaced will be nearly 1 9-16 in. apart.

(459) J. B., Stamford, Conn., writes: 1. I want to make a boiler containing 15 square feet of heating surface of the lightest possible weight to safely carry a pressure of 100 pounds per square inch. Will you advise me as to the best type of boiler and best material? *A.*—In our opinion an internally fired vertical boiler will answer your purpose. The dimensions of such a boiler should be: fire-box, 24 inches inside diameter, 30 inches high; outer shell, 30 inches outside diameter, 54 inches high; one flue, extending from the crown sheet of fire-box to head of outer shell, 8 inches diameter. All plates to be of steel; thickness of fire-box, ¼ inch; thickness of fire-box crown sheet, 5-16 inch; outside shell, ¼ inch thick; and outside head ⅜ inch thick. The bottom of the fire-box to be united to the shell by flanging the former. Three hand holes, not less than 2 x 3 inches, should be placed at the bottom of the boiler, and at least one hand hole 2 x 3 just above the crown sheet. Stay bolts should be run from the crown sheet to the outer head; the fire-box and shell should also have stay bolts. In this boiler there is a water space of 2½ inches between the fire-box and shell, which may, as well as the steam room above the crown, be somewhat reduced, thereby reducing the weight of boiler. But if conditions will permit, it will be best to adopt the dimensions here given, as plenty of water space around the fire-box, and a sufficient steam space, will give better and safer results. 2. How thick should a copper pipe be ¼ inch external diameter to stand 100 pounds' pressure per square inch? *A.*—The thickness of the copper should be about .009 inch. Since the thickness of copper pipes is not made so small as required for the given pressure, the lightest copper pipe that is made will be strong enough to withstand the pressure of 100 pounds per square inch.

(460) W. E. W., Philadelphia, Pa., asks: 1. Is there any rule or formula for setting the head of a milling machine in cutting the teeth on angular cutters, so as to bring the tops of the teeth to a uniform width? *A.*—We do not know of any such formula being used, though one could be formulated if there would be any advantage in it; but there would be no practical advantage in such a formula, because, having to take into account the angle of the cutter with which the milling is being done, and the angle, diameter, and number of teeth to be cut in the blank, the computation of the angle would be more trouble than is required to set the head by trial. The angle at the bottom of the tooth, and consequently the angle to which the head is set, is of course always somewhat less than that of the blank, and by setting the head at what appears to be about the right angle, running a light cut across, to mark the cutting edge of one tooth, and then indexing for the next one behind it, and making the adjustment necessary to bring the "land" parallel, you will find you can do it in less time than would be required to figure the angle. You will find, also, that after a little practice you will seldom fail to set the head just right at the first trial. At least that has been the writer's experience. 2. How can the proper cutter be selected with regard to its angle? *A.*—Only by the exercise of judgment, guided by experience and the observation of other good working cutters. A cutter straight on one side and 60° on the other is most used, but there should be a full set of them, both right and left hand, from 45° to 80°, varying by 5°, and the selection of the cutter for any given tooth must depend upon circumstances. 3. Will the same rules apply to work held in the chuck as to work held between centers? *A.*—The angle of the cutter blank to the platen would be the same, but the angle to which the head would be set would not be the same unless the length of the arbor on which the blank is placed is of such a length that its angle with the platen will equal that of the head. Each arbor of different length will be at a different angle with the platen, with the same setting of the head. This is upon the supposition that the tail center is at a fixed height, and the angle is obtained by elevating or depressing the head only. You will find some valuable points regarding this matter in our issue of April 18, 1885, p. 3. The device for milling taper work there described is in use by expert milling machine men who value it highly.——Please give directions for the following two examples: I have a cutter upon an arbor held in the chuck ready to mill that is 2 inch diameter, 90° on one side, 45° on the other (from the center line); the latter is to be cut; now 4. What is the proper number of teeth? *A.*—18 or 20, depending upon what it is to be used for, and the width of its face; if very wide, the diameter at one side will be so much below two inches that not so many teeth can be put in, and yet give opportunity for grinding conveniently. 5. How ascertained? *A.*—By dividing the circumference of the cutter by the pitch of the teeth desired, which usually should be about 5-16 inch. 6. What angle of cutter shall I use? *A.*—60° to 65°, according to circumstances. 7. What degree shall I set the head to? *A.*—Set it by trial, as described above, and if you choose, make a record of it for future use.——I have a taper reamer 5 inches long, 2 inches taper to the foot, 1⅛ inches largest diameter. I wish to cut it on centers, and can depress the head of the machine as well as raise it. 8. What is the proper angle to set it to in order to bring the teeth as wide on top at the point as at the head? *A.*—We cannot tell you. The subject is discussed in the article referred to above. 9. What is the proper angle of cutter? *A.*—It should have no angle in the sense in which you mean it, but instead of being straight on the back it should be at an angle of about 5°, in order to cut the front face of the teeth smooth. The cutter should be set so as to bring this face radial, however. The other side should be curved, and the best way to determine its shape is to observe the shape of teeth in good reamers. 10. What is the proper number of teeth? *A.*—The greatest number you can get into the small end and have room for grinding, which will be 10 or 12.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

See Grant's Gear advt. on back page.

Link-Belting.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

See our new designed engine lathes in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed drill presses in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed shapers in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed brass working tools in Cincinnati Centennial Exposition, Lodge, Davis & Co.

2,000 feet of space in Cincinnati Centennial Exposition, Lodge Davis & Co.

See special adv't, page 16, Lodge, Davis & Co.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Lamb Knitting Machine Co., Chicopee Falls, Mass.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

"The Bulldozer," a new departure; forging by pressure. M'f'd by Williams, White & Co., Moline, Ill.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

"Swift" Sight Feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.

Davis Key-Seating Machines, kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

Mechanical drawing, calculations, etc., taught by correspondence. I. Donald Boyer, Dayton, Ohio.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Drawings, mach. patterns and models. Inventors ideas perfected. Valentine, 15 Alling st, Newark, N. J

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st., Chicago, Ill.

Patents—Whittlesey & Wright, 705 8th st., N. W. Washington, D. C. Send for pamphlet and references.

Ice and Refrigerating Machines, 124 built, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Upright drills, improved, sizes 21", 23", 25", 28", 32", 36" swing; finely made and great capacity. Currier & Snyder, Worcester, Mass.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

If you visit the Ohio Centennial at Cincinnati, see the Waterhouse Arc Light Plant. W. N. Gray, agent, 56 Longworth st., Cincinnati, Ohio.

R. G. DuBois, solicitor, counselor and expert in patent cases, 916 "F" st., Washington, D. C. Corresp. solicited; highest ref's.; send for pamphlet.

Machinists' supplies, brass goods, m't'rs supplies, polishing materials, all kinds wire, metals, etc., in any quantity. Jordan & Gottfried, 208 Canal st., N. Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N. Y. Send for des'n.

Fine tools and supplies for machinists and other metalworkers. Get our prices before purchasing elsewhere. Montgomery & Co., 105 Fulton st., N. Y. City.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Oct. 6, p. 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches; working drawings for the transmission of power by steam, water, air and electricity.

Contract work of all kinds executed promptly and on reasonable terms. Parties wishing gray iron castings in large quantities can make money by corresponding with Rawson Mfg Co., Hornellsville, N. Y.

A system of easy lettering by J. H. Cromwell, giving 26 forms of alphabets. The space to be lettered being divided into squares; simple and effective. Price 50 cents. Catalogue of books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N. Y.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

The series of articles by J. G. A. Meyer, on "Practical Drawing," now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including Sept. 22, 1888 issue, 59 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction," by J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 73 articles have thus far appeared up to and including the Sept. 15, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York

MANUFACTURES

J. H. Rucker will build an ice factory at Athens, Ga.

S. J. Montague is interested in starting a wagon factory at Raleigh, N. C.

The Jones Hollow Ware Company has been incorporated at Baltimore, Md.

The Star Broom Works is the name of a new enterprise at Little Rock, Ark.

The Trion Manufacturing Company, Trion, Ga., will build another cotton mill.

The F. S. Lovel Machine Company, Fitchburg, Mass., will enlarge their shops.

The Winnipisogee Paper Company, Franklin, N. H., are building a large pulp mill.

H. B. Edgerly is making large additions to his shoe factory at Farmington, N. H.

The Delaware and Hudson Canal Company are building a new shop at Whitehall, N. Y.

The Ohio Valley Foundry at Bellaire, Ohio, was recently destroyed by fire. Loss, $60,000.

The Forsman Malleable Iron and Cast-Steel Company will build a foundry at Louisville, Ky.

The Calumet Woolen Company, Uxbridge, Mass., are building an addition to their woolen mill.

A company known as the Newport Aluminum and Cast-Steel Company has been organized at Newport, Ky.

The Athens Mining and Manufacruring Company is interested in building a flour mill at Athens, Tenn.

The Manufacturers Aid Association is interested in building a spoke factory, to employ about 50 men, at Jackson, Tenn.

A company known as the G. H. Grimm Manufacturing Company (iron works) has been incorporated at Hudson, Ohio.

The R. D. Cole Manufacturing Company, Newnan, Ga., will make quite extensive additions to their boiler shop and machine shop equipments.

The Mason Regulator Company, Boston, Mass., have purchased land upon which they will at once proceed to erect shops. The shops are to be completed this fall.

The Dean Brothers Steam Pump Works, Indianapolis, Ind., send us their new catalogue, which contains cuts and descriptions of pumps made by them; also useful tables and data.

The Atlantic Cotton Mills of Lawrence, Mass., purchased last year forty-five arc lights (Waterhouse system), and have just ordered of the Waterhouse Electric & M'f'g Co., Hartford, Ct., seventy-seven arcs additional.

The Gordon Steam Pump Company, Hamilton, Ohio, has issued a new illustrated catalogue of pumps and pumping machinery. In addition to cuts and descriptions, the catalogue contains information of value to engineers and mechanics.

The Salem Iron Works, Salem, N. C., write us that they think some man competent to repair circular saws and to make planer knives, moulding bits, etc., could do a good business in that town, judging from inquiries they receive and cannot attend to.

The Lloyd Booth Company, of Youngstown, Ohio, are having an excellent run of business, having lately moved in their new machine shop, which was built and supplied with new tools last summer. They are now prepared to build machinery of every kind, but especially rolling mill and furnace work. Besides a new shop they also built a large air furnace for melting very heavy castings.

There is agitation for new water-works, or the enlargement of existing works, at Gladwin, Mich.; Pinconning, Mich.; Brantford, Canada; Massillon, Ohio; Lachine, Canada; Minneapolis, Minn.; Shelbourne, Canada; St. Cloud, Minn.; Lebanon, Ky.; Sidney, Ohio; Osborne, Kan.; Waycross, Ga.; Greeley, Col.; Richmond, Ky.; Acworth, Ga.; Malden, Me.; Schenevus, N. Y.; Greenville, Ohio; Groveton, N. H.

The Universal Radial Drill Company, Cincinnati, Ohio, are building what they believe to be the largest radial drill ever built in this country. It has an arm 9 feet long, and will take 8 feet under the spindle, which is 4 inches in diameter. The column is 18 inches diameter, 12½ feet high, base 6 x 13 feet, and the whole machine will weigh about 24,000 pounds. It goes to the Cramp Ship Building and Engine Company, Philadelphia, and will be used in the construction of the Government cruisers, for which they have contracts.

The Kelly & Jones Company, 75 John street, New York, and 141-143 First avenue, Pittsburgh, Pa., manufacturers of brass and iron goods, for steam, gas and water; also tools and specialties, have issued a large and elegant bound catalogue illustrating their goods. The firm are also agents for the sale of pipe cutting machinery, steam and gas fitters' tools and engineers' outfits, which are illustrated. The catalogue contains a large number of tables and considerable general reading matter that will be found valuable to engineers, machinists and manufacturers.

The Ansonia (Conn.) Brass and Copper Company are the sole manufacturers of "Tobin Bronze," an alloy that is said to be remarkable for its tensile strength, rigidity and toughness. It is said to behave well under the hammer, bolts and nuts being made from it either by hand or machinery. It is also said to be a very suitable metal for marine purposes; also for valve and valve faces, engine bearings, etc. It remelts without trouble, and if directions are followed can be worked into any desired shapes. Tests have been made of this alloy by Prof. Thurston, and others, that show remarkable strength, and other desirable qualities. The Naval Department has specified its use, after elaborate tests. The New York offices are at Nos. 19 and 21 Cliff street.

H. R. Jones, master mechanic for the Smelting and Refining Works at Pueblo, Col., writes: Our new copper works are progressing finely. We are putting in two bucket elevators and conveyor belts for elevating copper matte. We are also putting in an elevator for elevating bullion. It is a steel screw winding machine, run by belt. We are having two boilers made of Otis steel, each 5 feet diameter and 14 feet long, with 42 tubes 4 inches diameter. We are putting in a Berryman feed water heater, and a Deane pump. We are laying over 3,000 feet of water pipe some of it 10 inches diameter. All stop valves in water mains, as well as fire hydrants, will be the "Chapman;" steam and water valves above ground will be the Jenkins Brothers', most of them gates. We shall use the "Eclipse" friction clutch pulleys for driving most of the crushers, rolls, elevators, etc. When the new plant is completed we will be using in the whole works about one million gallons of water daily. The works will have electric lights.

The Portage Lake Foundry and Machine Works [Houghton, Mich.], of which Messrs. Stephen E. Cleaves & Son are proprietors and managers, are showing just now some marked signs of growth and prosperity. The twelve acres of lake front land belonging to Mr. Cleaves, and containing his shops and dwellings, have been fairly well covered with buildings heretofore, but more of the space is soon to be occupied in that way. The machine shop addition, which was begun in June, is now completed, except the erection of the machinery. Its dimensions are 40 x 40 feet, while those of the shop as it stood before are 40 x 80 feet, making the completed building 40 x 120 feet. The principal piece in the machinery equipment, of the addition, is to be a lathe weighing twenty-eight tons, the largest in the Upper Peninsula outside of the machine shop of the Calumet and Hecla Mining Company. It is being made by the Niles Tool Company, of Hamilton, Ohio, and will arrive in a short time. A strong stone foundation for a new foundry building, 62 x 150 feet in size, has recently been laid around the foundry building now used.—*Houghton Mining Gazette.*

Machinists' Supplies and Iron.

New York, Oct. 4, 1888.

Iron—American Pig—The general condition of the market is much the same as per our last report. The market rules quiet, consumers showing no disposition to stock up beyond present requirements. We quote Standard Lehigh and North River brands $18.50 to $19 for No 1 X Foundry, No. 2 Foundry, $17 to $17.50, and Grey Forge $15.50 to $16.25.

Scotch Pig—We quote Coltness, $22; Gartsherrie, $21; Summerlee, $22; Eglinton, $19.25 to $19.50; Dalmellington, $20.25 to $20.50; Clyde, $20.50, and Langloan, $20.50.

Antimony—Prices remain the same, with a moderate jobbing demand for Regulus. We quote Hallett's 10c. and Cookson's 12¾c. to 12⅞c.

Tin—We quote for jobbing lots of Banca 24c.; Straits and Malacca, 23⅝c. cash, and 23¾c. 30 days; Billiton, 24c.; Australian, 23⅝c. cash, 23¾c. 30 days.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Wanted—Men to examine S. S. planes; see p. 11.

Mech'l draftsman and designer, has had practical shop exp., wants position. Box 20, Am. Machinist.

Wanted—Position by man with 10 years' experience on motive power accounts, last part as chief clerk; best references. Box 24, Am. Machinist.

Wanted—Travelers for New England and Middle States, to handle mechanical goods; liberal commission. Box 17, American Machinist.

Wanted—Work at machine pattern making by experienced stove pattern maker, with some exp. on machine work; best ref. Pattern, Am. Machinist.

Wanted—A mechanical draftsman of practical shop experience. Apply by letter, stating age and experience, to Box 28, American Machinist.

Wanted—Position as supt. or foreman of foundry by sober, reliable man; 28 years' experience; best references. D. H., American Machinist.

Young man, theoretical education, with two years in machine shop, wants position, with prospect of advancement, in a good manufacturing concern. Box 27, American Machinist.

A young man wants permanent employment as mechanical draftsman; is a machinist and college graduate, with 8 years' exp. in m'f'g and designing of machinery; best refs. P. M., Am. Machinist.

A superintendent soon at liberty desires to re-engage; locomotive and heavy machine work, foundry work, heating furnaces and forgings; boilers and steam work. C. M., care Am. Machinist.

Wanted—Position by a practical mechanic of many years' experience as foreman or supt. with manufacturer of small work. Can handle large bodies of men, also construct and design automatic mach'ry; good ref's. given. Box 30, Am. Machinist.

A young mechanic who has had experience at tool making, brass, experimental, electrical, and general fine work, also as foreman, wants a position as foreman in a mechanical establishment R. S. B., American Machinist.

Wanted—A foundry foreman, one who is skillful, energetic and ambitious, who understands both locomotive and lighter work, and who would be willing under favorable conditions to get out the work at a price per pound. Address, with full record of experience, Box 522, Taunton, Mass.

Superintendent Wanted—We can place a first-class man in correspondence with parties who want a superintendent for large foundry and machine shop; a fine position for a man capable of swinging a large shop. Address with full particulars and references, Box 31, American Machinist.

Wanted—A superintendent for agricultural implement factory in Ontario, manufacturing binders and mowers; must be a man of good executive ability, thoroughly conversant with tools and latest methods of doing work, and competent to direct men to the best advantage. Apply, stating age, and salary expected, to Box 29, American Machinist.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Crescent steel tube scrapers are unquestionably the best. Crescent Mfg. Co., Cleveland, Ohio.

Crescent boiler tube cutter, for setting new and removing old tubes. Crescent Mfg. Co., Cleveland, O.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

August C. Christensen, 24 State st., N. Y., consulting engineer for hydr. and pumping machinery, etc.

Small metal goods made to order, die work, etc. S. G. Metal Works, 528 North 10th st., Phila., Pa.

Correspondence solicited with parties having machine or foundry specialties to build. Honesdale Iron Works, Honesdale, Pa.

For Sale—One No. 1 Baker Blower, one each, 1½' 2½" Merriman bolt cutters, all new and complete. The McLagon Foundry Co., New Haven, Ct.

Wanted—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

Hardware, light machinery and models in brass, iron or steel made to order in small or large quantities. Catalogue of model supplies and tools free. Goodnow & Wightman, Boston, Mass.

Wanted—New or second-hand planer, 24" or 28" by 6' or 8'; must be in first-class condition and cheap; give full particulars and weight. Address C. B. C., American Machinist.

For Sale—Pump Business. The very best rotary pump on the market, or would associate additional capital for enlarging the business. This pump has a splendid record, first-class testimonials and solid patent. From $3,000 to $6,000 takes patterns, stock on hand, orders, tools and patent. Address Pump, care American Machinist.

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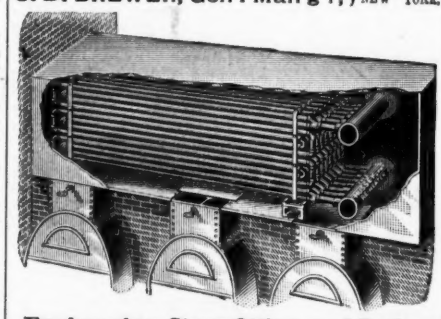
S. D. BREWER, Gen'l Man'g'r, }



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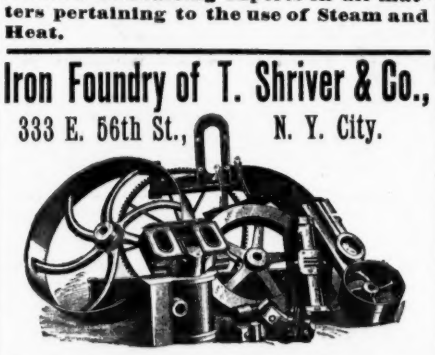

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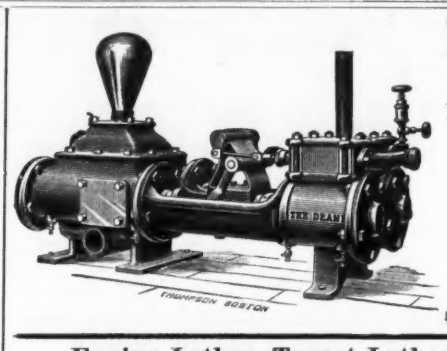

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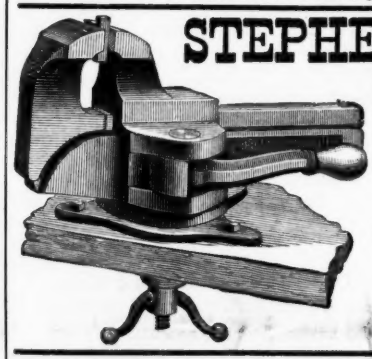

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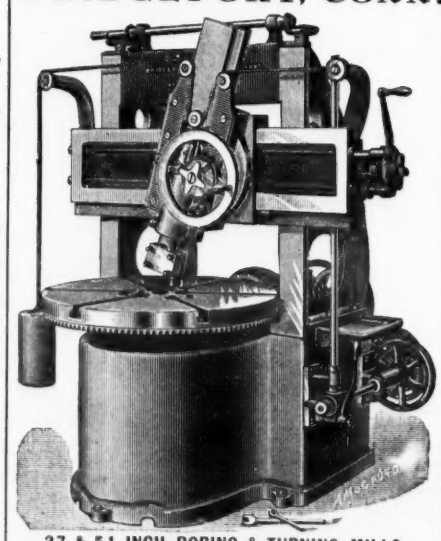

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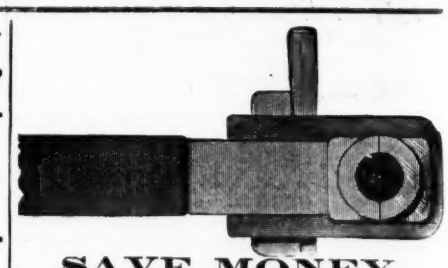

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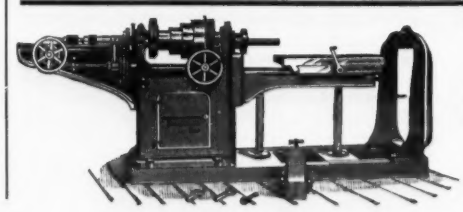

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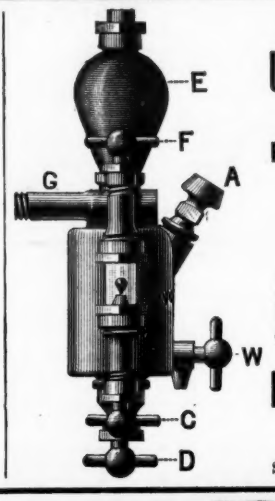

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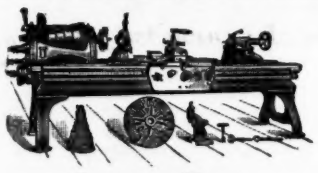

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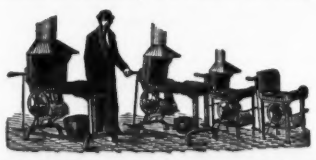

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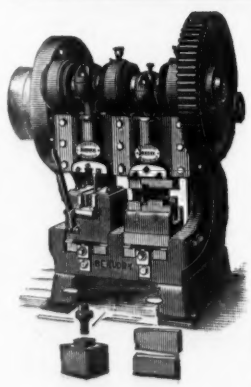

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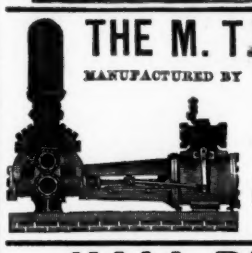

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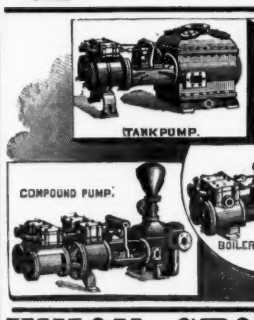

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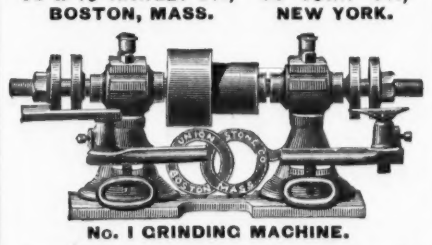

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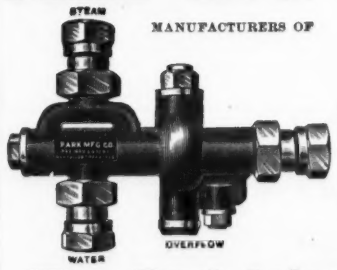

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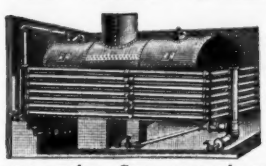

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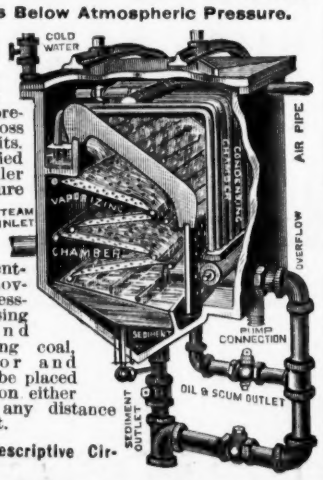

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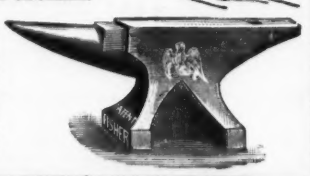

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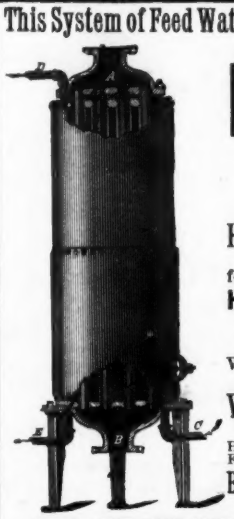

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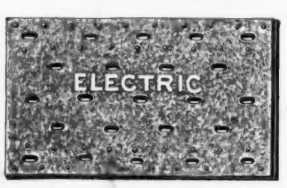

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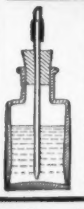

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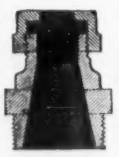

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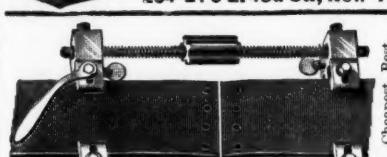

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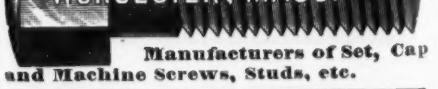

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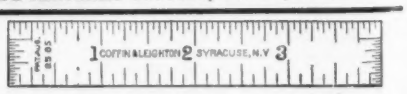

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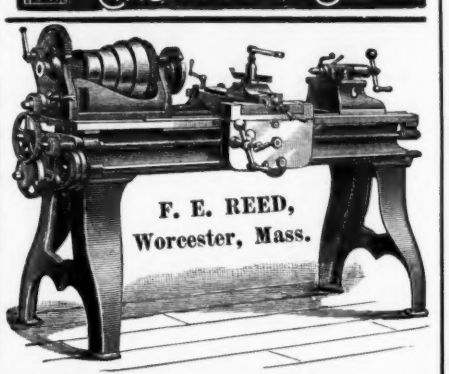

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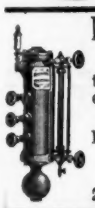

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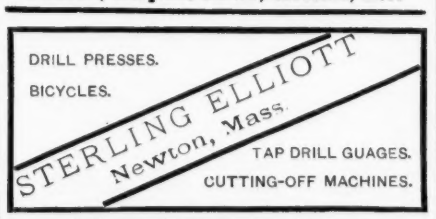

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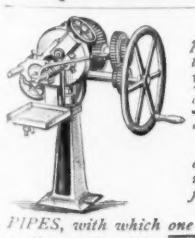

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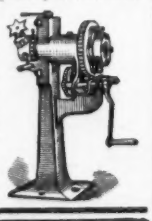

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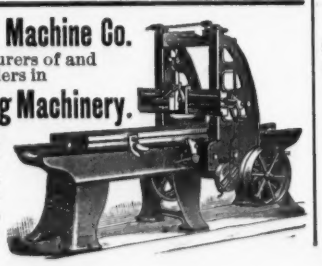

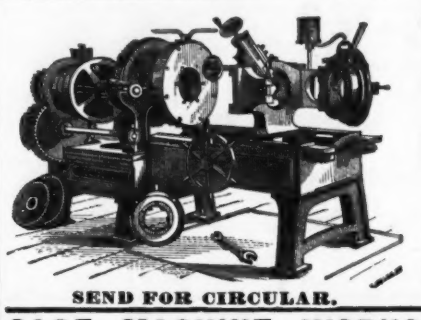

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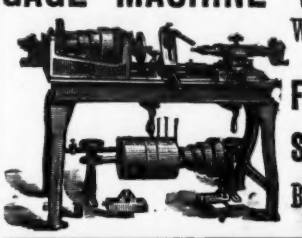

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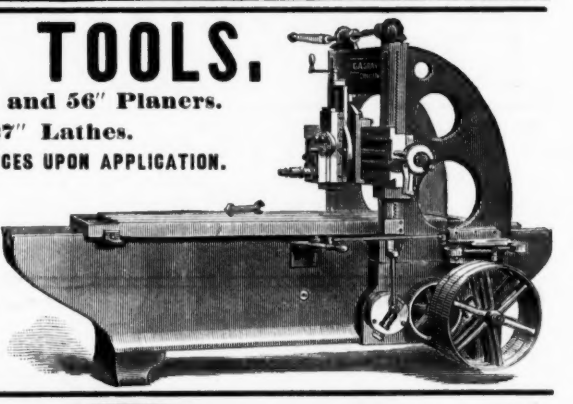

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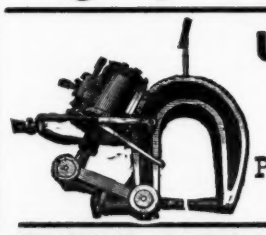

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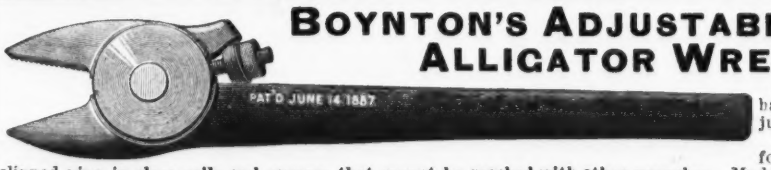

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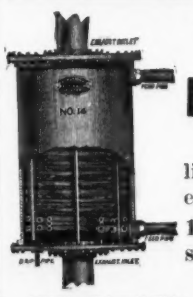

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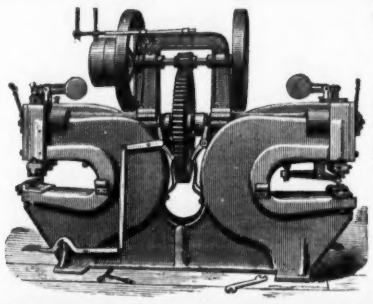

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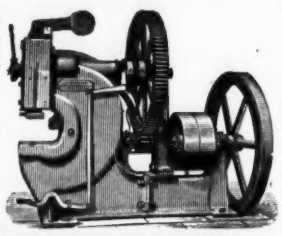

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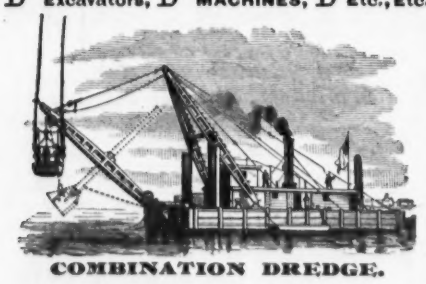

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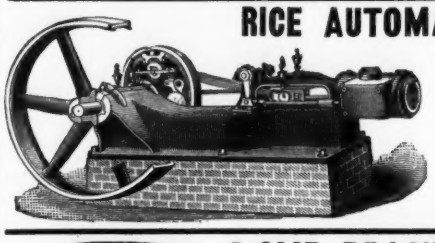

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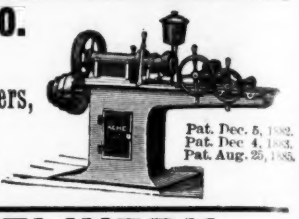

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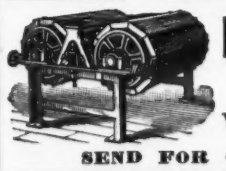

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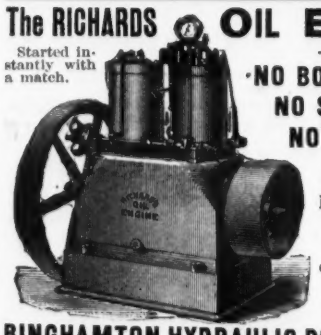

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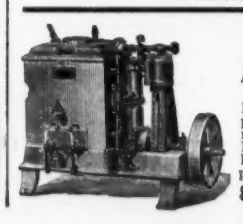

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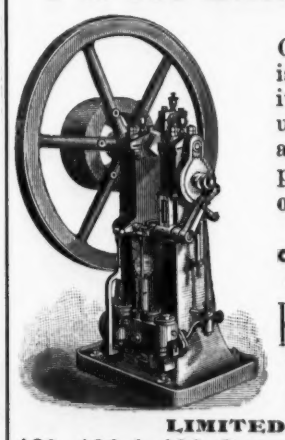

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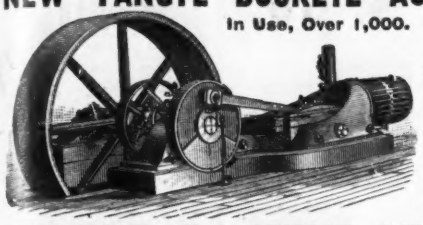

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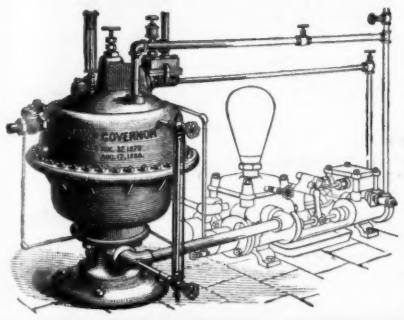

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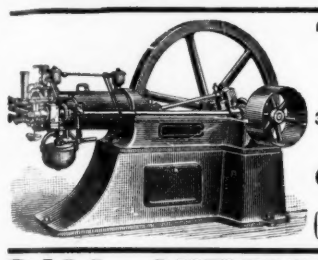

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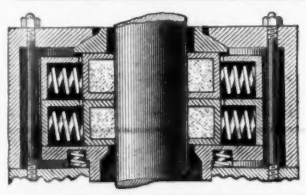

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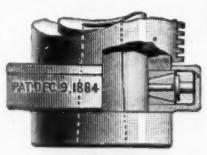

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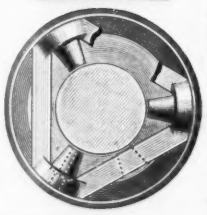

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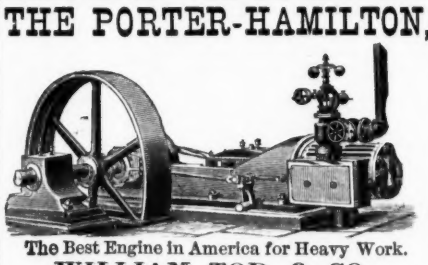

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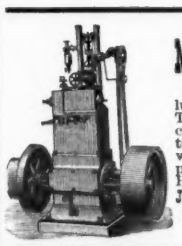

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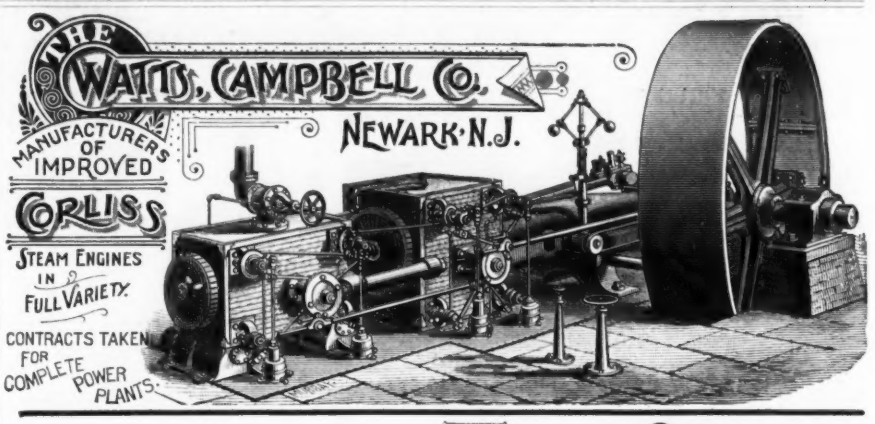

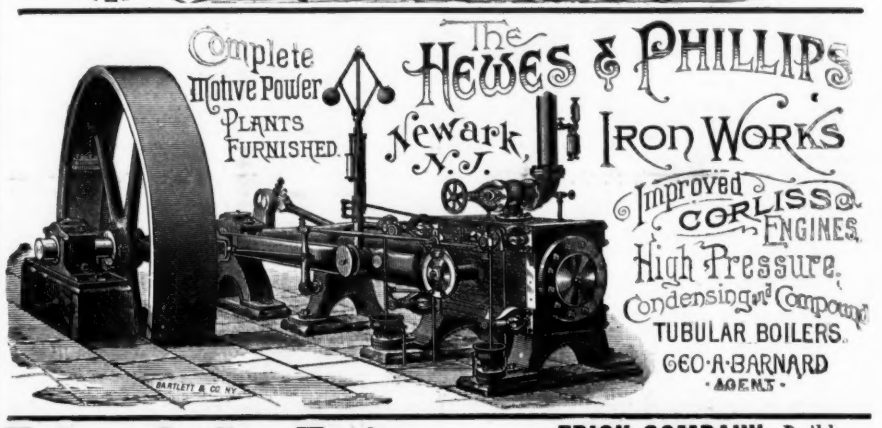

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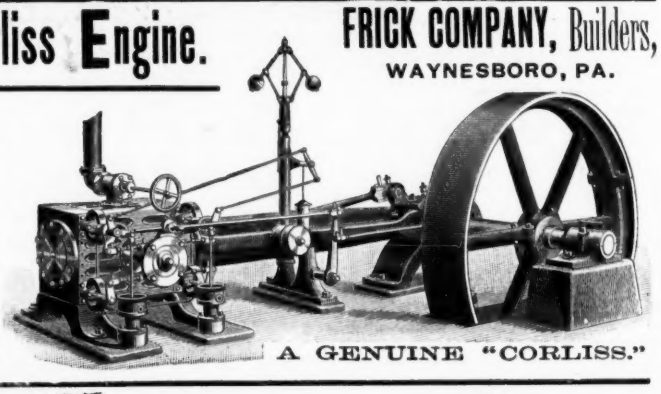

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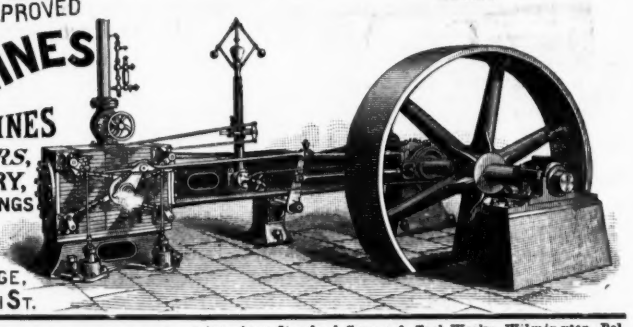

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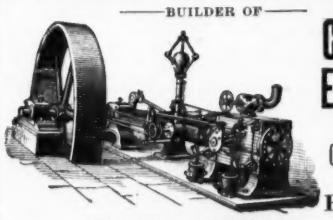

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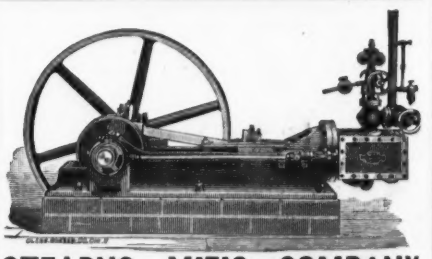

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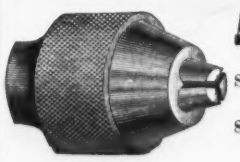

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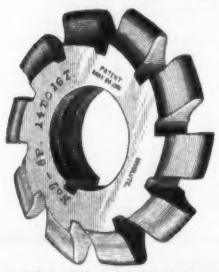

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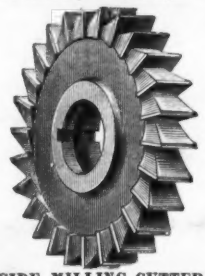
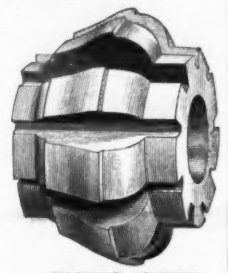


SIDE MILLING CUTTER.



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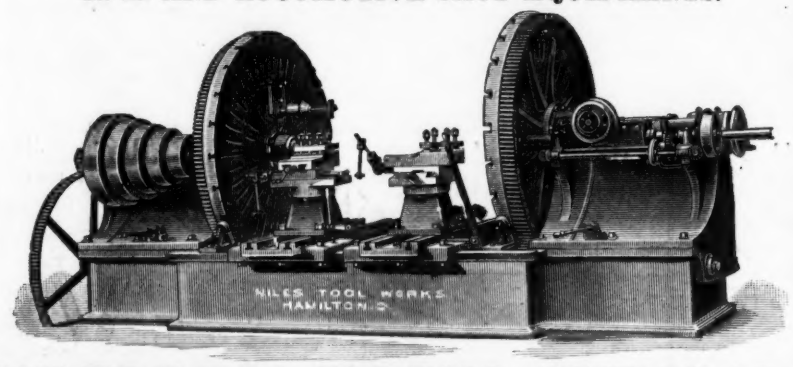

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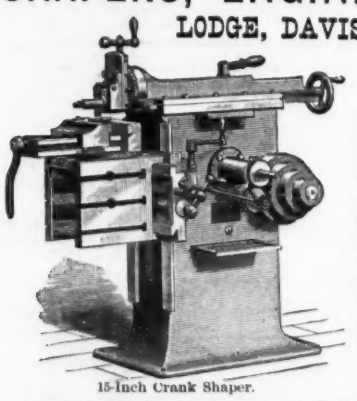

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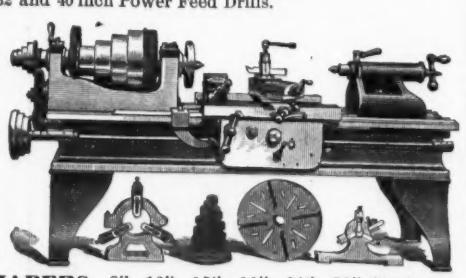

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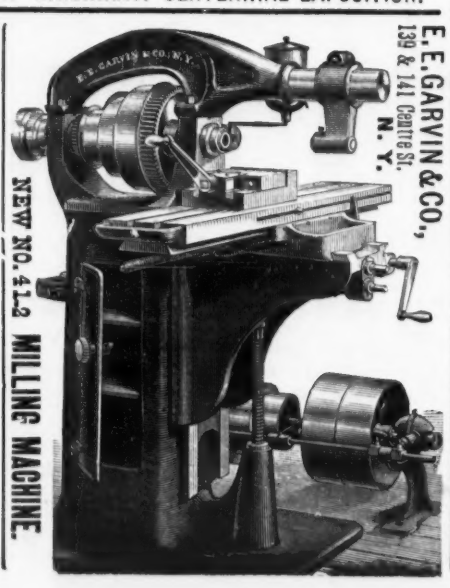

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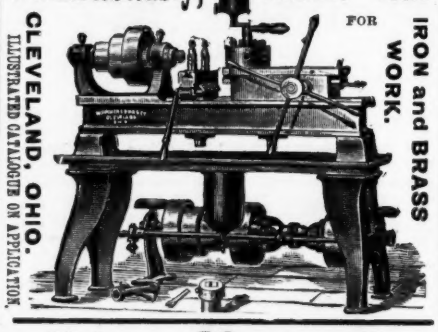

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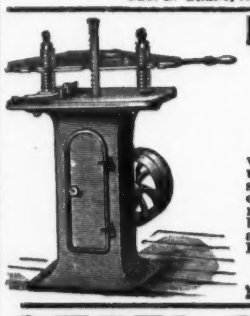

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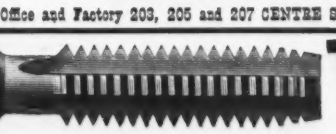

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